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WAR MACHINE

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Modern Naval Anti-Aircraft Weapons

Typical of the light AA armament in use today, the EMERLEC-30 is designed to cope with air and surface targets, and possesses a limited anti-missile capability. The twin 30-mm Oerlikon cannon with associated below-deck magazine are typical, but less so is the enclosed operator's cabin.

The widespread introduction of the surface-to-air missile seemed for many years to signal the end of the anti-aircraft gun, both on land and at sea. Modern war has shown this to be a short-sighted attitude, the experience of large-scale air attack in the Falklands proving the value of the gun, especially in a balanced gun/missile defence.

It was not too long ago that the Royal Navy's experts on air defence were blithely stating that guns were no longer needed aboard ship, except for use in the 'junk-bashing' role, if at all. However, luckily for the Royal Navy and before it faced a real exponent on the use of anti-shipping air power, the Falklands war of 1982 against Argentina proved the folly of those sentiments once and for all. The anti-aircraft gun of whatever calibre proved to be a major component of the air defences used. Such guns could be relied upon to put up a fairly heavy barrage, and even if it was at times relatively inaccurate, this barrage was sufficient to discourage a fair number of Argentine pilots on bombing and rocket runs, while the hits the guns recorded resulted in two absolutely confirmed kills plus an unknown number of damaged aircraft that limped home to bases on the mainland.

For defence against the anti-ship missile, the Falklands war proved that the ideal situation is in fact a combination of fully automatic guns with short-range point-defence missiles, the combination effectively creating around the ship a 'no-go area' for fast-approaching attackers. The calibres in this field usually vary from 20 mm up to 30 mm because of the high rate of fire required. The larger calibres are also represented, but for anti-missile work require sophisticated electronics coupled with the use of reliable proximity-fused fragmentation ammunition to ensure a kill.

It is interesting to note that the Soviets predated the Americans into this field with a CIWS (Close-In Weapon System) against missiles because of their experience of such weapons. The Western European navies, such as those of France and the UK, initially failed to show interest, preferring instead to concentrate on their missile systems. However, the latter country (together with several other NATO nations such as the Netherlands and Spain) have now adopted the CIWS as part of their naval armament. Surprisingly, relatively few other countries are following suit despite the combat experience to prove how useful such systems are.

Fitted with two Breda Compact Twin Naval Mount Type 70s, the Peruvian 'Lupo' class frigate Meliton Carvajal *can utilize them in an integrated DARDO CIWS (Close-In Weapon System) for use against anti-ship missiles.*

B.A.P. CARVAJAL

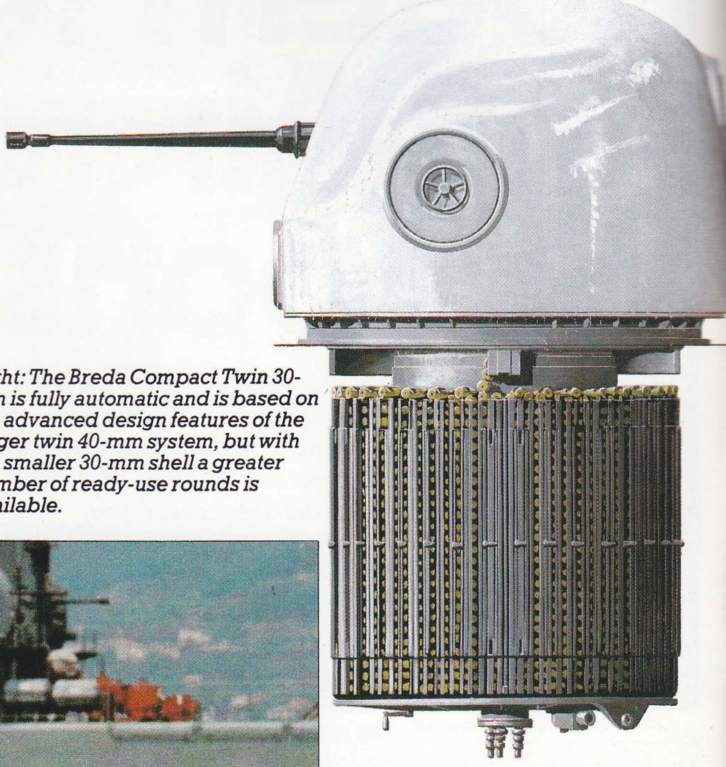
ITALY

Breda Twin 30-mm Naval Mount

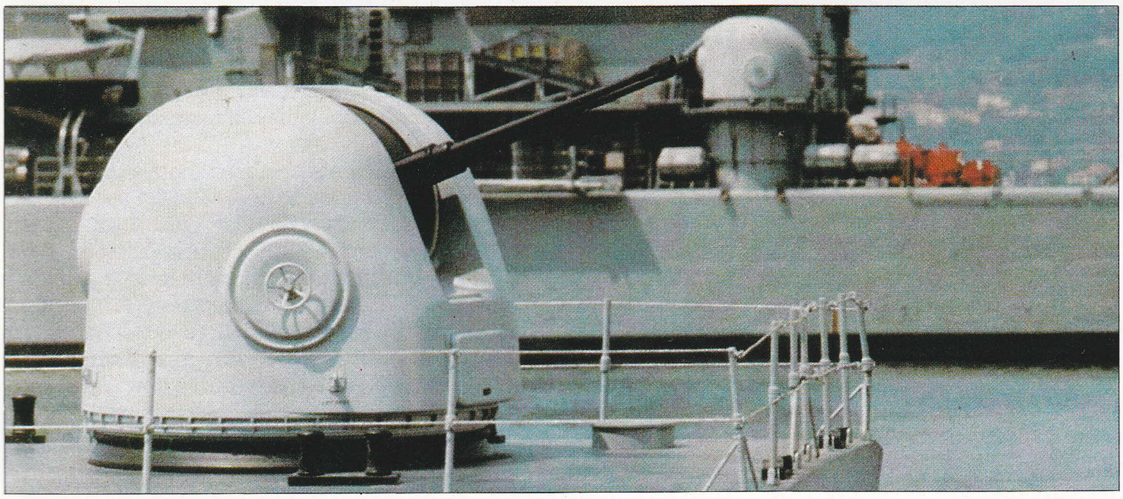
Designed for the export market, the **Breda Twin 30-mm Naval Mount** uses two Mauser MK cannon set in a twin cradle within a turret. Some of the advanced features of the twin 40-mm L/70 mount described separately have been incorporated into the design to reduce reaction time to a minimum. The mount is completely automated, with sufficient ammunition reserves (2,000 belted ready-use rounds per mount) to meet both saturation and successive wave attacks without the need for human intervention to replenish stocks. Four versions are available to meet siting arrangements in various classes of warships. In each case the dimensions and weights have been reduced to the minimum to save topweight. The ammunition is the same as that developed for the American GAU-8 tank-buster cannon, and comprises two basic types: an HE-incendiary round with an impact fuse and an AP-incendiary round with the penetrator made out of depleted uranium. A production line has been set up in anticipation of orders.

Specification

Breda 30-mm
Calibre: 30 mm
Number of barrels: two
Elevation: −13° to +85°
Muzzle velocity: 1040 m (3,412 ft) per second
Effective range: 3000 m (3,280 yards)
Rate of fire: 1,600 rounds per minute
Weight: varies according to the ship type fitted
Number of rounds carried on mount: 2,000

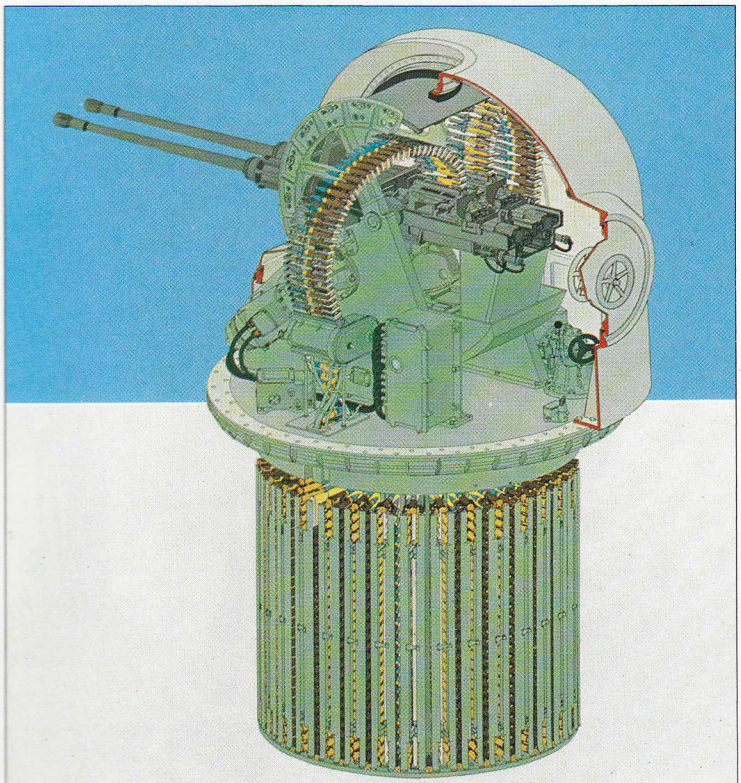


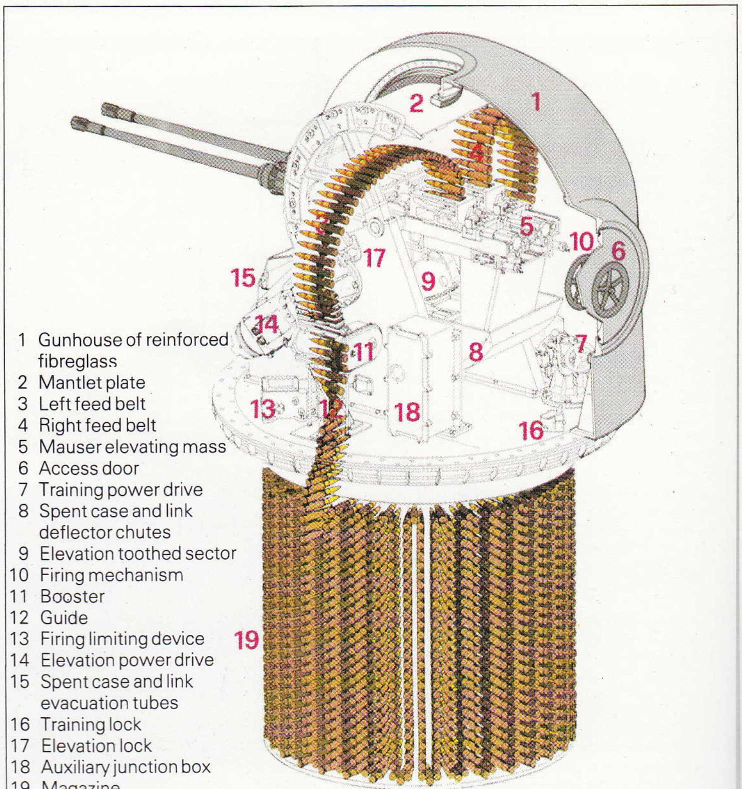
Right: The Breda Compact Twin 30-mm is fully automatic and is based on the advanced design features of the larger twin 40-mm system, but with the smaller 30-mm shell a greater number of ready-use rounds is available.



The Breda Compact Twin 30-mm Naval Mount is now in production: first examples are for missile patrol craft of an unspecified customer. In the background is a 'Lupo' class frigate with twin 40-mm turret visible.

The general layout of the gunhouse and below-decks magazine for 2,000 ready-use rounds is seen in the cutaway drawings below. Already the Breda company has designed a single 30-mm naval mount along the same lines and firing the same GAU-8/A ammunition types.



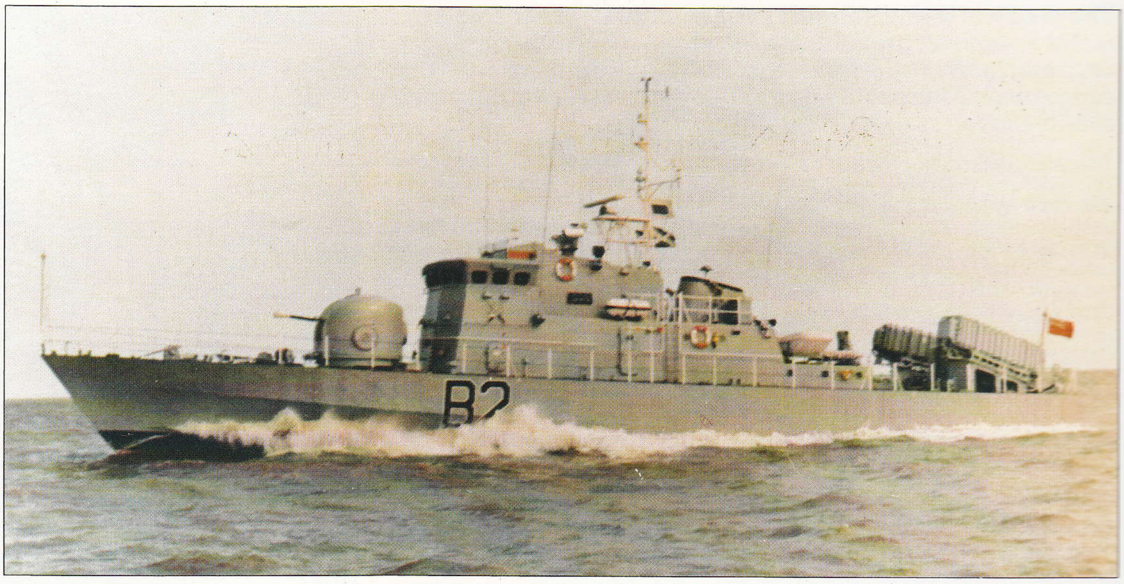


1 Gunhouse of reinforced fibreglass
2 Mantlet plate
3 Left feed belt
4 Right feed belt
5 Mauser elevating mass
6 Access door
7 Training power drive
8 Spent case and link deflector chutes
9 Elevation toothed sector
10 Firing mechanism
11 Booster
12 Guide
13 Firing limiting device
14 Elevation power drive
15 Spent case and link evacuation tubes
16 Training lock
17 Elevation lock
18 Auxiliary junction box
19 Magazine

ITALY

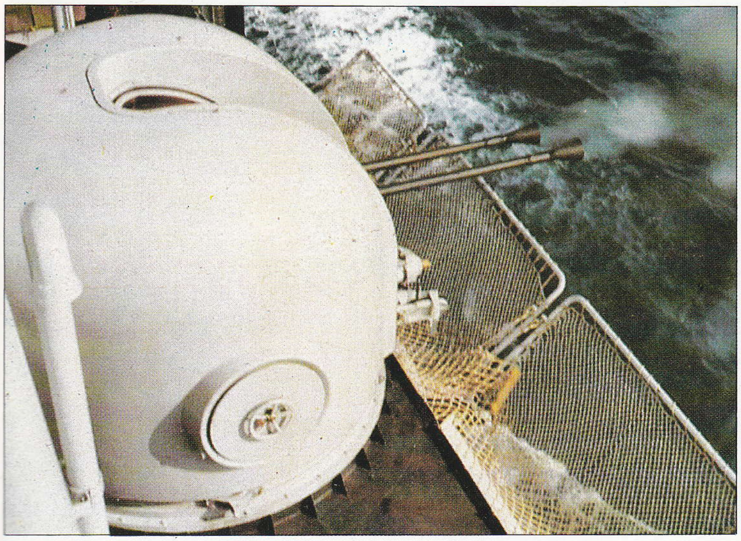
40-mm L/70 Breda Compact Twin Naval Mount Type 70

The **40-mm L/70 Breda Compact Twin Naval Mount Type 70** is a joint venture by Breda Meccanica Bresciana and Bofors to produce a system intended for point-defence use against aircraft and anti-ship missiles. The mount is fully automatic in operation, and features a high rate of fire with a considerable ready-use ammunition supply to the two guns, which are laid by remote-control high-performance servo-units. The mount is available in two versions, the **Type A** and **Type B**, which differ only in weights and the amount of ammunition carried in the turret's magazine (736 rounds in the Type A and 444 in the Type B). In each variant the magazine itself is divided in to two halves, each with hoist serving one barrel. Three types of ammunition are fired: 40-mm AP tracer, 40-mm HE direct action (with impact fuse) and 40-mm HE proximity-fused. Both turrets are in production and service with a number of navies worldwide, especially as secondary armament on missile craft. When the mount is coupled to a Selenia RTN-20X I/J-band fire-control radar with a direct electronic link to the ship's main surveillance radar and fire-control system, the weapon then forms part of the **Dardo** close-in weapon system designed specifically to counter high-speed late-detection attacks by anti-ship missiles. It does this by utilizing the turret's rapid-response characteristics and high rate of fire (together with proximity-fused ammunition) in order to ensure a kill. The Dardo CIWS is widely fitted in frigate-sized and larger vessels of the Italian navy, and has also been exported to several countries who have bought Italian frigates and missile corvettes.



The Omani navy missile boat Al Mansur *mounts a 40-mm L/70 Breda Compact Twin Naval Mount Type 70 'B' forward, carrying a total of 444 rounds in its magazine below decks. The weapon can be used in both the air defence and surface attack roles, a flexibility important in smaller navies.*

Specification
L/70 Breda Compact
Calibre: 40 mm
Number of barrels: two
Elevation: −13° to +85°
Muzzle velocity: 1000 m (3,281 ft) per second
Effective range: 3500-4000 m (3,830-4,375 yards) depending upon target type
Rate of fire: 600 rounds per minute
Weight: (with ammunition) Type A 7300 kg (16,093 lb), and Type B 6300 kg (13,889 lb)
Number of rounds carried on mount: see main text



B.A.E. ESMERALDAS

Left: The heavier twin 40-mm Breda Type A variant of the L/70 Type 70 mounting is used on larger warships, as it has a more capacious magazine with 736 ready-use rounds below decks and is some 1000 kg (2,200 lb) heavier. More than 20 navies have adopted the Type 70.

Above: The Ecuadorean corvette Esmerelda *is typical of the general-purpose vessels in service with many navies. It is armed with Exocet SSMs and an OTO-Melara 76-mm dual-purpose gun in addition to the AA armament of Albatros missiles and the 40-mm L/70 Type 70 twin gun.*

SPAIN

20-mm Meroka Close-In Weapon System

Developed by CETME, the **20-mm Meroka CIWS** consists of a turret with two rows each of six 20-mm automatic Oerlikon cannon, a PDS-10 control console which incorporates a digital fire-control computer, a RAN-12/L search and target-designation radar, and an on-mount PVS-2 monopulse Doppler I/J-band tracking radar with low-light thermal-imaging TV camera. The combined rate of fire of the barrels is some 9,000 rounds per minute, although only 720 rounds are actually carried on the mount itself. An additional 240 rounds apiece are carried in each of three externally fitted boxes. The normal mode of action is by radar control, but the camera can be used for manual standby operations via a monitor unit and controls on the below-decks console. Twenty systems have been ordered by the Spanish navy in place of more expensive foreign CIWS such as the Phalanx. The allocation is due to be four on the carrier *Principe de Asturias*, one for each of the six 'Descubierta' class frigates and one for each of the five new 'FFG-7' class missile frigates. The remaining five are to be introduced on the five 'Baleares' class ASW frigates from 1985 onwards as they undergo their mid-life refits. The Meroka will be fitted on the stern. No export sales are expected.

Specification
Meroka
Calibre: 20 mm
Number of barrels: 12
Elevation: not known
Muzzle velocity: 1200 m (3,937 ft) per second
Effective range: 2000 m (2,185 yards)
Rate of fire: 9,000 rounds per minute
Weight: 4500 kg (9,921 lb)
Number of rounds carried on mount: 1,440

Fire Control Systems

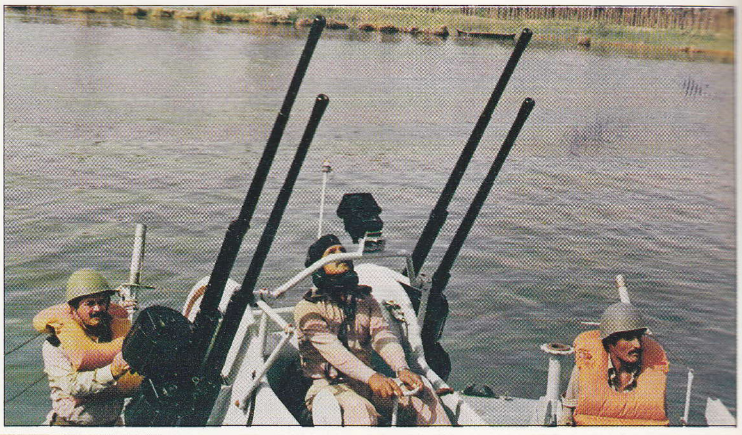
The problem with defending surface ships from aerial attack is that an aircraft provides a small target moving fast and unpredictably. The advent of sea-skimming missiles has compounded the problem, necessitating maximum efficiency in anti-aircraft systems.

The key to defending a surface combatant in modern naval warfare is the use of computerized command and control action-information systems located in a central operations room below decks. Here are co-ordinated all the data from the vessel's various sensors, inter-ship data-links, and weapon-control systems to build up an accurate set of plots of the tactical air, surface and sub-surface activity within a given volume round the platform. Once a potential threat is detected and determined to be hostile, then the appropriate weapon-control system is assigned to deal with it. In the case of a medium- to high-level aircraft or missile threat, initial detection may well be by the ship's long-range air-search radar, which uses a broad beam that scans through 360° every minute or so to indicate the presence but not the precise location of a possible target. The raw data from the search radar is then used by the relevant operations room personnel to key in a narrower-beam fire-control radar to the specified target in order to fix its flight direction and exact location. The information or target track thus gained is then fed into the computerized control system of a missile-launcher or anti-aircraft gun mount in order to direct the weapon in elevation and bearing so as to engage the incoming target. The computer then calculates the optimum engagement distance and for a gun the number and duration of burst. Such systems were in the majority amongst the Royal Navy ships in the Falklands, and could not cope very well with the Argentine low-level attacks coming out of the surrounding terrain when they operated close to shore.

To deal with this type of attack by low-flying aircraft, and with targets such as sea-skimming anti-ship missiles like the Exocet and the Soviet 'pop-up' SS-N-7, the conventional long-range and fire-control radars have to be replaced by a combined search and target-tracking set mounted on a completely automatic defence system with extremely rapid response times. There are a number of these 'last-ditch' close-in weapon systems now available, such as the 20-mm Phalanx, the 25-mm Skyguard and the 30-mm Goalkeeper. All are characterized by fully automatic operation from target detection to destruction, and once activated they will endeavour to shoot down all rapidly-closing targets in order of priority unless overridden by the operations room.

For those ships without the sophisticated electronics-equipped operations room and fire-control systems, reliance is placed back on optical detection and tracking devices. The oldest of which is the 'Mk 1 Eyeball' coupled with a simple ring and bead sight on the gun itself. The best example of this is the Royal Navy's elderly 20-mm Oerlikon cannon as currently used on most of its surface combatants. Further up the scale is the gyro-stabilized optical sight, while the ultimate is the fitting of low-light television or infra-red camera units which can be used in poor visibility and at night, a capability which was hitherto unavailable to air-defence guns unless they were directed by radar.

For the future, laser designators are already being tested both as a means to guide laser-homing shells and to give continuous and reliable ranging for close-in targets.

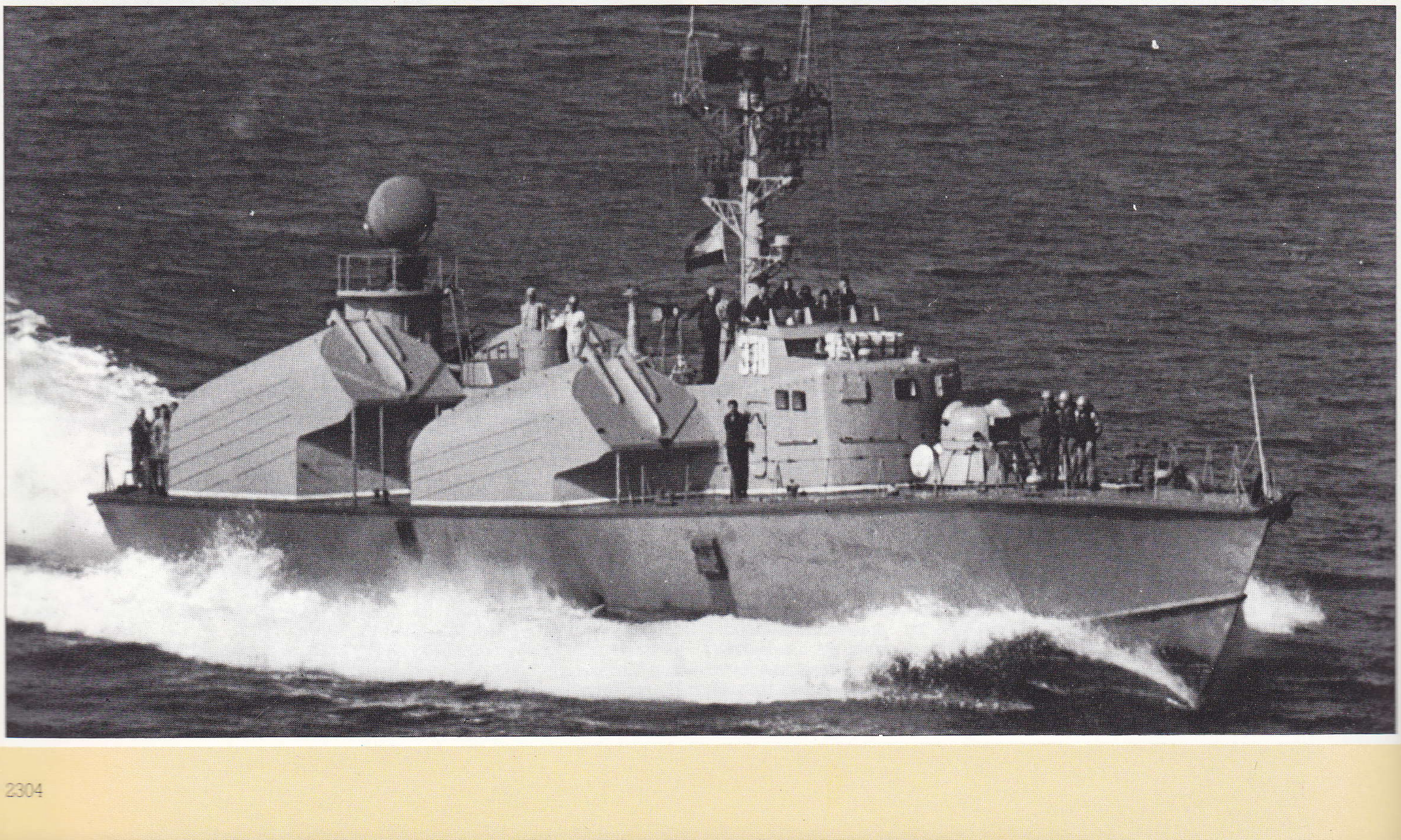


The Iraqis have produced their own anti-aircraft gun system based on four Yugoslavian 20-mm guns (derived from the 20-mm Oerlikon). Fire control is the simplest available, comprising the human eye and a simple sighting system with manual bearing and elevation controls.

Although the level of sophistication of fire-control systems is increasing rapidly, the 1982 Falklands war also demonstrated the fact that although such systems can be present aboard ship, there is still a need for as much firepower as can safely be carried by the ship to be brought to bear on the incoming target(s). Whether or not this weight of fire hits the target aircraft is not entirely relevant, as by its mere presence in the area of the target during the attack it can cause the pilot to lose his nerve and break off or delay weapons release sufficiently for them to miss. If the target is a missile, then the greater the weight of metal thrown at it the better the chance of hitting it hard enough to destroy it.

Where the fire-control system comes in, whatever its level of sophistication, is that it should ensure the guns be pointed in the correct direction at the right time and at roughly the correct elevation before the engagement begins. The Royal Navy learnt to its cost that it is no good having on paper some of the world's best available air-defence systems if the associated electronics are not capable of engaging manoeuvring targets but only those which appear like target drones, flying a straight and level course. These inadequacies should have by now been rectified in order for the Royal Navy to be capable of meeting a far more sophisticated threat in the form of the Warsaw Pact.

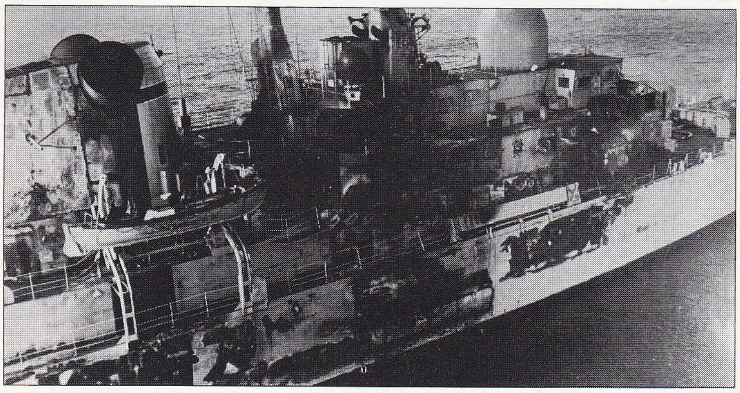
This 'Osa' class missile boat of the Egyptian navy is not typical in that its fire control system and associated 'Drum Tilt' radar (visible on the platform aft) control only the 30-mm guns. Comparable Western systems control guns, torpedoes and missiles, in addition to providing search and track facilities.



Above: One of the two major elements in any fire control system is the radar. The Italian DARDO system employs the Orion RTN-20X radar, developed specifically for use with close-in weapon systems.

Above: The other main element is the computerized control centre in the ship. Typically, as in the Selenia example above, it will consist of an operator's console for the weapon system and a tactical data display.

Above: The Mk 92 FCS developed for the US Navy's PHM hydrofoil programme was designed for air and surface actions using guns and missiles. The system includes search radars, tracking radar, IFF and navigation radar as well as standard target illumination radar, and is integrated into a computerized command and control system.



Left: The price of failure – the charred hulk of HMS Sheffield *after being struck by an Exocet missile. Ships' fire control systems must react in seconds to shoot down sea-skimming missiles to avoid a similar fate.*

Below: The Mk 86 gun fire control system fitted to the most recent US surface combatants can operate in several operational modes, including radar-directed surface fire, air action, anti-ship missile defence, visual surface fire and indirect short bombardment.

USSR

30-mm anti-aircraft guns

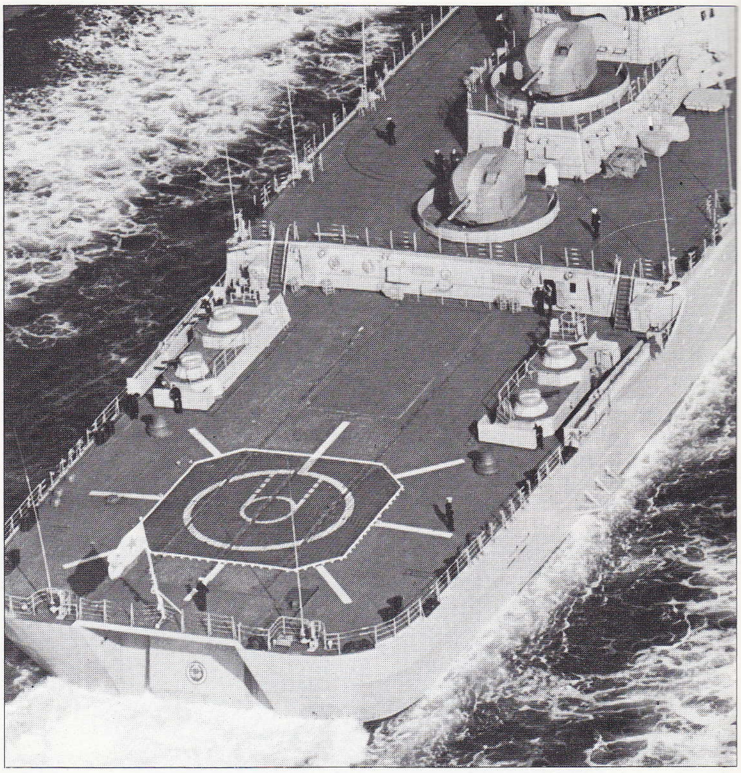
The first Soviet 30-mm mount was the **AK-230** 60-calibre system which entered service in 1960 to replace the elderly 25-mm 60-calibre twin anti-aircraft gun on new-build major and minor warship classes. The small enclosed turret is usually known by the nickname Dalek because of its physical appearance. The two 30-mm cannon fitted are fully automatic in operation, and the barrels are water-cooled. The theoretical maximum rate of fire for the guns is 1,050 rounds per minute, but the maximum realistic rate to prevent damage is actually in the region of 200-240 rounds per minute. The guns are usually used in conjunction with a 'Drum Tilt' fire-control radar or a remote optical director. On the smaller ships fitted with the AK-230 an anti-surface role is also assigned to the type, the maximum effective range being 2500 m (2,735 yards). A shell weighing 0.54 kg (1.2 lb) is used. The system has been widely exported to Soviet-supplied states as the gun forms the main armament of the 'Osa' class missile craft.

To counter the threat of missile attack the Soviets developed the 30-mm weapon further to produce a 'Gatling' gun version with six 30-mm barrels inside a larger barrel-like cylinder in a similar shaped mount known by the designation **AK-630**. This is designed to fire at a fast rate as large a number of the 0.54-kg (1.2-lb) shells as possible, with high-density metal penetrators to destroy cruise missile sized targets at relatively close range. Usually mounted in pairs with a 'Bass Tilt' fire-control radar, the mount is in service on the 'Kiev', 'Kara', 'Udaloy', 'Sovremenny', 'Slava' and 'Kresta II' classes, and has been retrofitted to several older ships. On smaller warships it is usually found as a single mount together with a larger-calibre gun and a fire-control radar. Each mount also has a remote fire-control optical director.

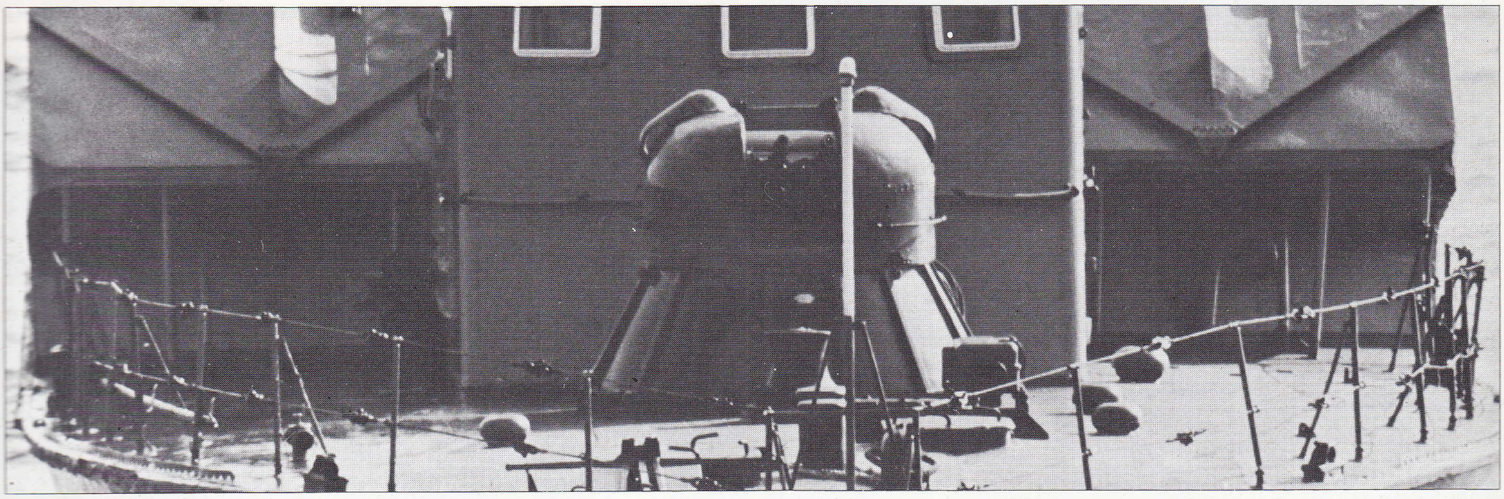
Specification
AK-230
Calibre: 30 mm
Number of barrels: two
Elevation: 0° to +85°
Muzzle velocity: 1000 m (3,281 ft) per second
Effective range: 2500 m (2,735 yards)
Rate of fire: 1,050 rounds per minute

Specification
AK-630
Calibre: 30 mm
Number of barrels: six
Elevation: 0° to +85°
Muzzle velocity: 1000 m (3,281 ft) per second
Effective range: 3000 m (3,280 yards)
Rate of fire: 3,000 rounds per minute

Right: Soviet distribution of CIWS is liberal, with vessels such as the nuclear-powered 'Kirov' class being equipped with up to eight 30-mm Gatling types, the four-stern turrets being shown here. The Soviets may have developed a high-density penetrator round for the system.



Below: The 30-mm turret for twin automatic cannon is standard fit aboard Soviet light force units and is shown on the bow of a Soviet navy 'Osa I' class missile boat. The turret has also been exported widely to Soviet client states.



USSR

57-mm anti-aircraft guns

The oldest of the Soviet navy's **57-mm anti-aircraft guns** is a single-barrel 70-calibre mounting which can still be found on some 'Skory (Mod)' destroyers. This version was followed in the late 1950s by a twin-barrel version which is found on a number of the smaller warship classes such as the 'T-58' class patrol vessels and radar pickets. The final version of the weapon to appear was a quadruple mount with the barrels arranged in two superimposed pairs. All three systems can be controlled locally, the twin and quad guns using either 'Hawk Screech' or 'Muff Cob' fire-control radars to obtain target data for below-decks electronics. The guns fire a 2.8-kg (6.2-lb) shell which has in recent years been fitted with a proximity fuse to increase its lethality against missile-type targets. The weapons can also be fired in the anti-surface target role, in which the maximum effective range is 8 km (5 miles).

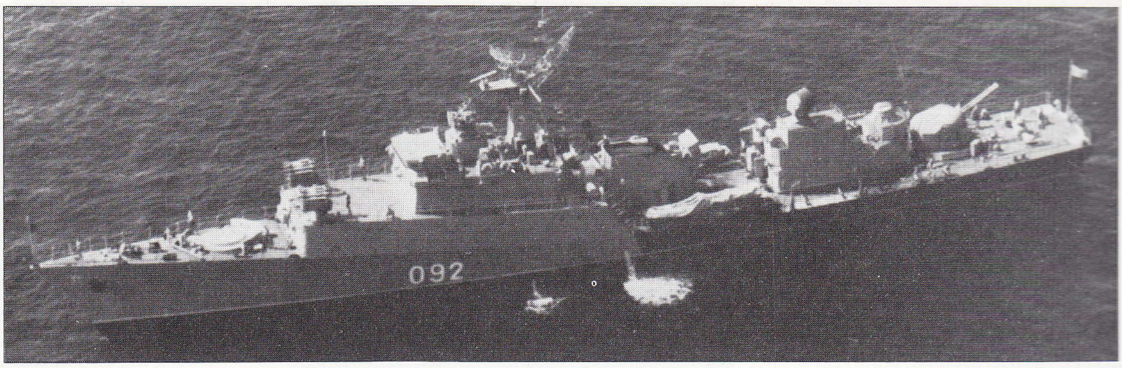
In the early 1960s a new twin 57-mm 80-calibre water-cooled dual-purpose mount was introduced into service. This is fully automatic in operation from the below-decks ammunition handling room to the gun mount itself. Classes fitted with the gun include the 'Moskva', 'Kresta I', 'Kresta II', 'Poti', 'Grisha I/II/III'. 'Nanuchka', 'Turya', 'Ropucha', 'Ugra' and 'Berezina'. The fire-control radars used are the 'Muff Cob' or 'Bass Tilt' systems, while the ammunition fired is of the same type as used by the 70-calibre gun.

Specification
57-mm L/70
Calibre: 57 mm
Number of barrels: one, two or four
Elevation: 0° to +90°
Muzzle velocity: 1000 m (3,281 ft) per second
Effective range: 4500 m (4,920 yards)
Rate of fire: 120, 240 or 480 rounds per minute

'Kanin' class units of the Soviet navy have two 57-mm quadruple mountings located forward and have been supplied with new proximity-fused ammunition.

Specification

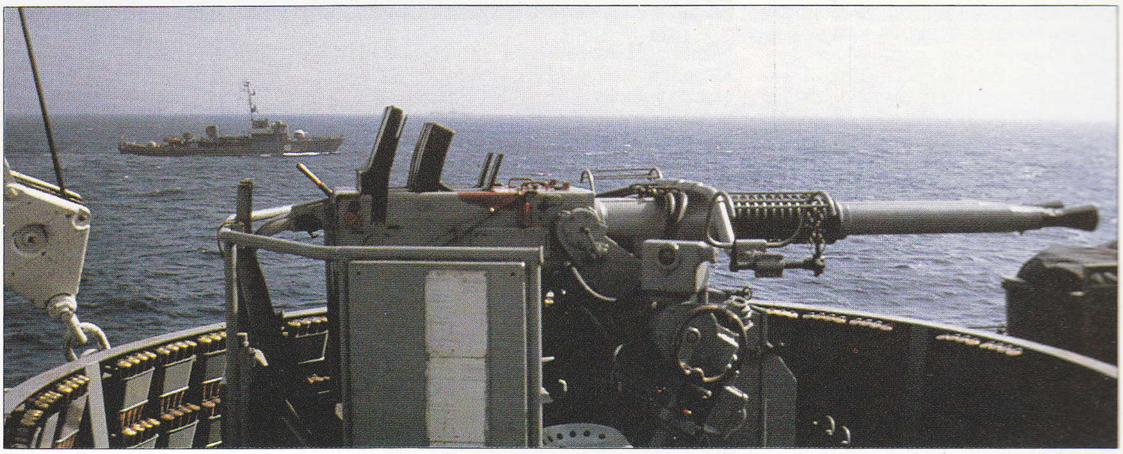
57-mm L/80
Calibre: 57 mm
Number of barrels: two
Elevation: 0° to +85°
Muzzle velocity: 1000 m (3,281 ft) per second
Effective range: 6000 m (6,560 yards)
Rate of fire: 240 rounds per minute



The twin 57-mm turret mounted aft on the Soviet 'Grisha III' class corvette was first introduced in the 1960s. Water-cooled, it is a fully automatic weapon with increased maximum range from that of its predecessor.

SWEDEN

40-mm L/60 and L/70 Bofors automatic guns



The original 40-mm L/60 Bofors was one of the principal air defence weapons of the US Fleet in the Pacific war. It served well into the 1970s and was last mounted on such vessels as the attack transport USS* Sandoval*, which is seen shadowed by a 'T-143' class minesweeper of the Soviet navy.

The original **40-mm L/60 Bofors** automatic anti-aircraft gun was introduced into use during the period of World War II, and today is still in service with a number of navies. It may also be fitted to some new-build warships in a reconditioned form as it is no longer in production. Present-day construction is now devoted to the higher performance **40-mm L/70 Bofors gun** variant, which is operational worldwide with more than 30 navies. Three basic types of single barrel mountings for the L/70 are offered, these differing in the amount of automation provided. Gun control can be either local or remote, the latter using either a below-decks fire-control system or an above-decks optical director.

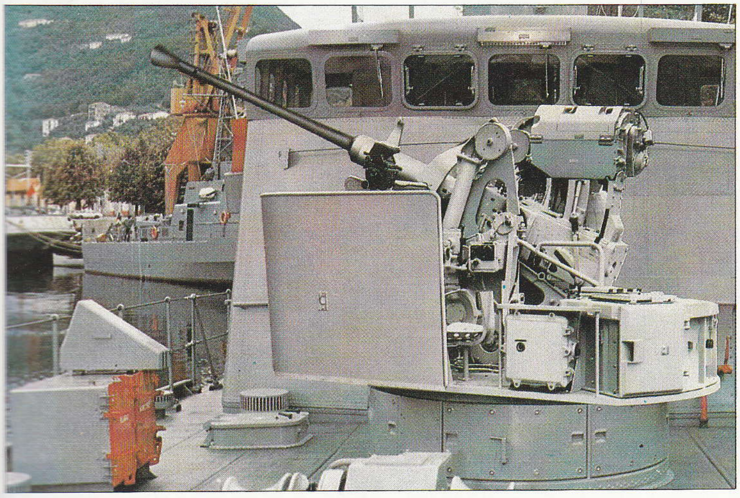
To increase the lethality of the older L/60, two new types of ammunition have been developed by the Swedes, a prefragmented HE (PFHE) round with a proximity fuse and an armour-piercing high-capacity tracer (APHC-T) round. The L/70 has its own family of ammunition which includes PFHE, HCHE, HE-tracer (HE-T) and practice types. The pulse-Doppler radar proximity fuses fitted to the two PFHE round types allows missile targets to be engaged, the L/60 version having an effective detonation distance of between 4.5 and 6.5 m (14.76 and 21.33 ft) and the L/70 round of between 1 and 7 m (3.28 and 22.97 ft) depending upon target size and type. The L/70 additionally forms part of the Italian Breda 40-mm single- and twin-barrel gun mounts, which are currently used by more than 20 navies.

Specification

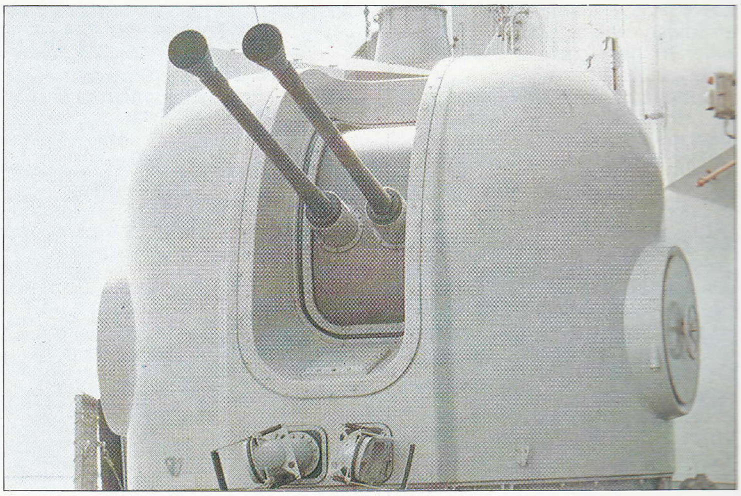
L/60 Bofors
Calibre: 40 mm
Number of barrels: one
Elevation: −10° to +80°
Muzzle velocity: 830 m (2,723 ft) per second
Effective range: 3000 m (3,280 yards)
Rate of fire: 120 rounds per minute
Weight: varies, but typically between 1200 and 2500 kg (2,646 and 5,511 lb)
Number of rounds carried on mount: varies according to mount type

Specification

L/70 Bofors
Number of barrels: one
Elevation: −10° to +90°
Muzzle velocity: 1005-1030 m (3,297-3,379 ft) per second according to round type
Effective range: 4000 m (4,375 yards)
Rate of fire: 300 rounds per minute
Weight: (without ammunition) SAK 40L/70-350 2890 kg (6,371 lb), SAK 40L/70-315 1700 kg (3,748 lb) and SAK 40L/70-520 3790 kg (8,355 lb)
Number of rounds carried on mount: SAK 40L/70-350 96, SAK 40L/70-315 96 and SAK 40L/70-520 144



The Breda/Bofors 40-mm L/70 naval mount with a Breda 144 round automatic feed device allows the number of men required on-mount to be reduced to two, with a third on standby to reload the feed mechanism during lulls in firing.



Among the most popular of Bofors mounts are those provided by Breda, the L/70 being used in both single and twin forms. The compact twin turret is currently in service or on order for more than 20 navies worldwide.

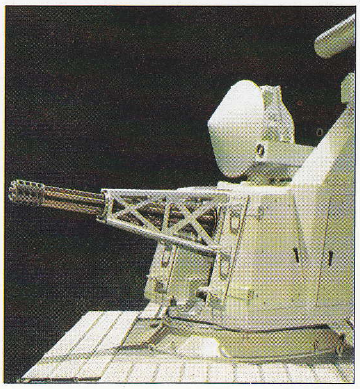
NETHERLANDS/USA

30-mm Goalkeeper Close-In Weapon System

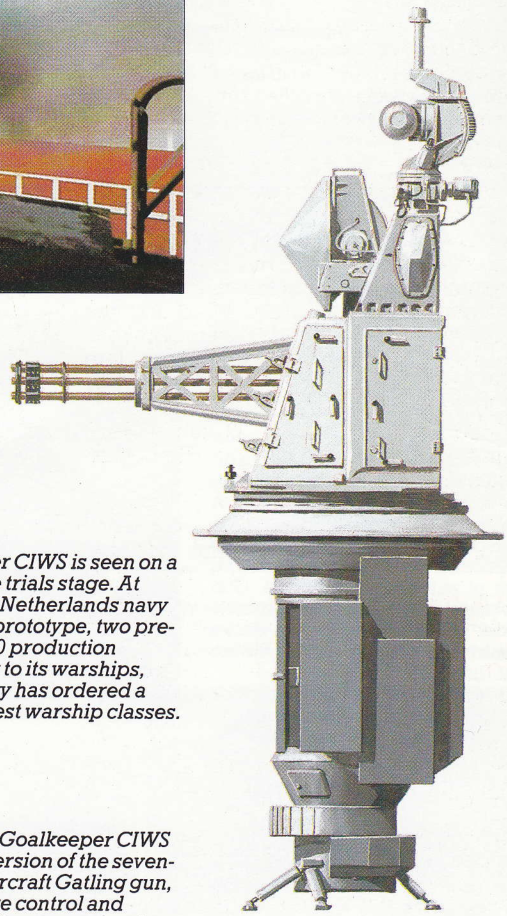
The **30-mm Goalkeeper CIWS** naval air-defence system is an autonomous radar-directed short-range weapon designed for fully automatic defence against high-speed missile and aircraft. Built as a joint venture by the American company General Electric and the Dutch company Hollandse Signaalapparaten BV, the Goalkeeper has all its elements integrated on a single mount like the Phalanx system. The Goalkeeper consists of an I-band track-while-scan search-and-acquisition surveillance radar, a dual-frequency I/K-band tracking radar, fire-control electronics and a cannon with high rate of fire, namely the 30-mm seven-barrel GAU-8/A Sea Vulcan version of the aircraft Gatling gun. System operation is completely automatic from target detection, through target destruction and termination of the engagment, to detection of the next target. Missiles flying as low as 5 m (16.4 ft) have been successfully destroyed, and the tracking radar can also be used against high-elevation diving targets. For multiple attacks there is an automatic kill-assessment subsystem to assign target priorities. The AP discarding-sabot round has, instead of the original depleted-uranium penetrator, one made of a high-density tungsten alloy. For softer targets an HE-incendiary round is employed. A total of 1,190 rounds is carried in a linkless-feed/drum-storage system. To replenish this storage/feed arrangement a bulk loading system is used, but in an emergency manual reloading can be performed. The Goalkeeper system has been chosen by the Royal Netherlands navy for its 'Kortenaer', 'Jacob van Heemskerck' and future 'M' class frigates. The Royal Navy has also ordered a number for fitting to its four 'Type 22 Batch 3' class frigates and the new 'Type 23' or 'Duke' class medium-sized frigates.

Specification
Goalkeeper
Calibre: 30 mm
Number of barrels: seven
Elevation: −25° to +85°
Muzzle velocity: 1021 m (3,350 ft) per second
Effective range: 3000 m (3,280 yards)
Rate of fire: 4,200 rounds per minute
Weight: (with ammunition) 6730 kg (14,837 lb)
Number of rounds carried on mount: 1,190

Left: Goalkeeper is able to engage multiple targets, the system having demonstrated kills of simulated supersonic anti-ship cruise missiles at ranges of 500 m and 400 m respectively within about one second of switching target.



Left: A Goalkeeper CIWS is seen on a test rig during the trials stage. At present the Royal Netherlands navy has ordered one prototype, two pre-production and 10 production systems for fitting to its warships, and the Royal Navy has ordered a number for its latest warship classes.



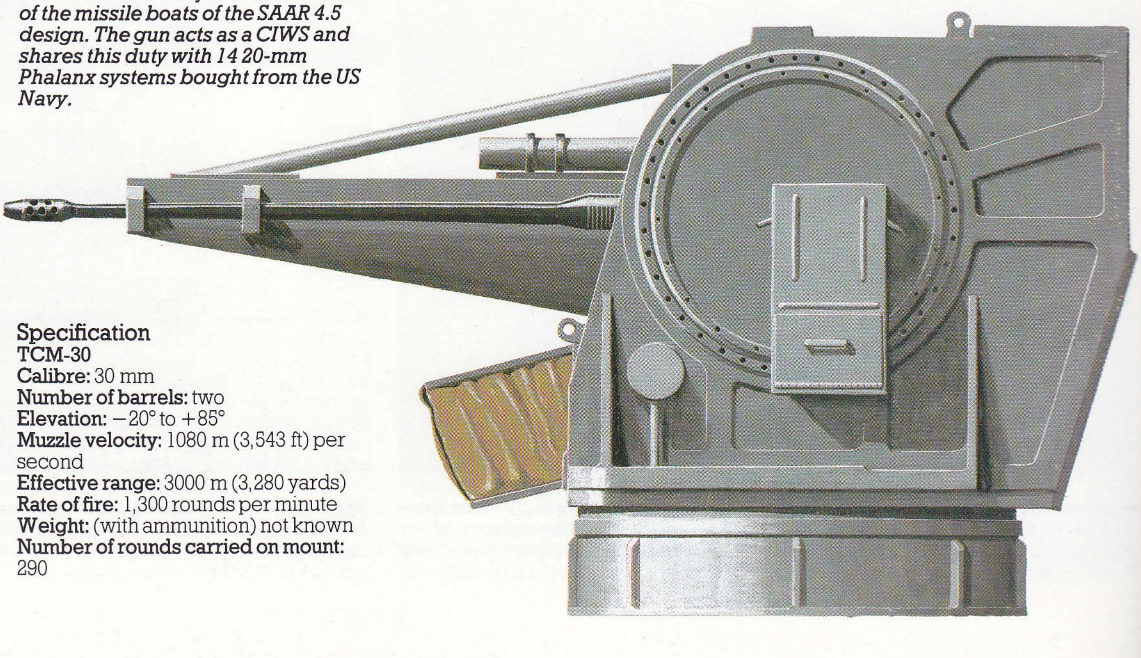
Right: The 30-mm Goalkeeper CIWS uses a modified version of the seven-barrel GAU-8/A aircraft Gatling gun, with integrated fire control and search radars on the same mount.

ISRAEL

30-mm TCM-30 Twin Naval Gun

Built by a subsidiary of Israel Aircraft Industries, the **30-mm TCM-30 Twin Naval Gun** consists of a pair of 30-mm automatic cannon and their feed systems mounted in a stabilized electrically-actuated turret capable of high angular accelerations. The cannon are 30-mm Oerlikon models, and are carried on a barrel-support system which reduces longer-range shot dispersion to a minimum. The turret's positioning and traverse velocity can be controlled from the ship's fire-control system. Five different types of ammunition can be used in the two 125-round linked-ammunition boxes that are located on the gun cradle. Two reserve magazines provide a further 40 rounds for the system. The TCM-30 is gradually replacing the older single-barrel Bofors 40-mm mounts fitted to the Israeli navy's missile craft after the prototype was tested aboard the 'Aliyah' class *Geoula*. The same gun has also been adapted for land use on a towed carriage and armoured fighting vehicles, as well as being employed in the **Spider II** air-defence artillery system. Under Israeli government regulations it is also being offered for export.

The TCM-30 twin 30-mm naval air defence weapon is now in service with the Israeli navy aboard several of the missile boats of the SAAR 4.5 design. The gun acts as a CIWS and shares this duty with 14 20-mm Phalanx systems bought from the US Navy.



Specification
TCM-30
Calibre: 30 mm
Number of barrels: two
Elevation: −20° to +85°
Muzzle velocity: 1080 m (3,543 ft) per second
Effective range: 3000 m (3,280 yards)
Rate of fire: 1,300 rounds per minute
Weight: (with ammunition) not known
Number of rounds carried on mount: 290

The Guns of San Carlos

The conflict in the Falklands was the first to see major surface units of a technologically advanced Western navy fighting off large-scale air attack from a determined and resourceful enemy. Among the many lessons learned, the value of conventional gun defence was not the least important.

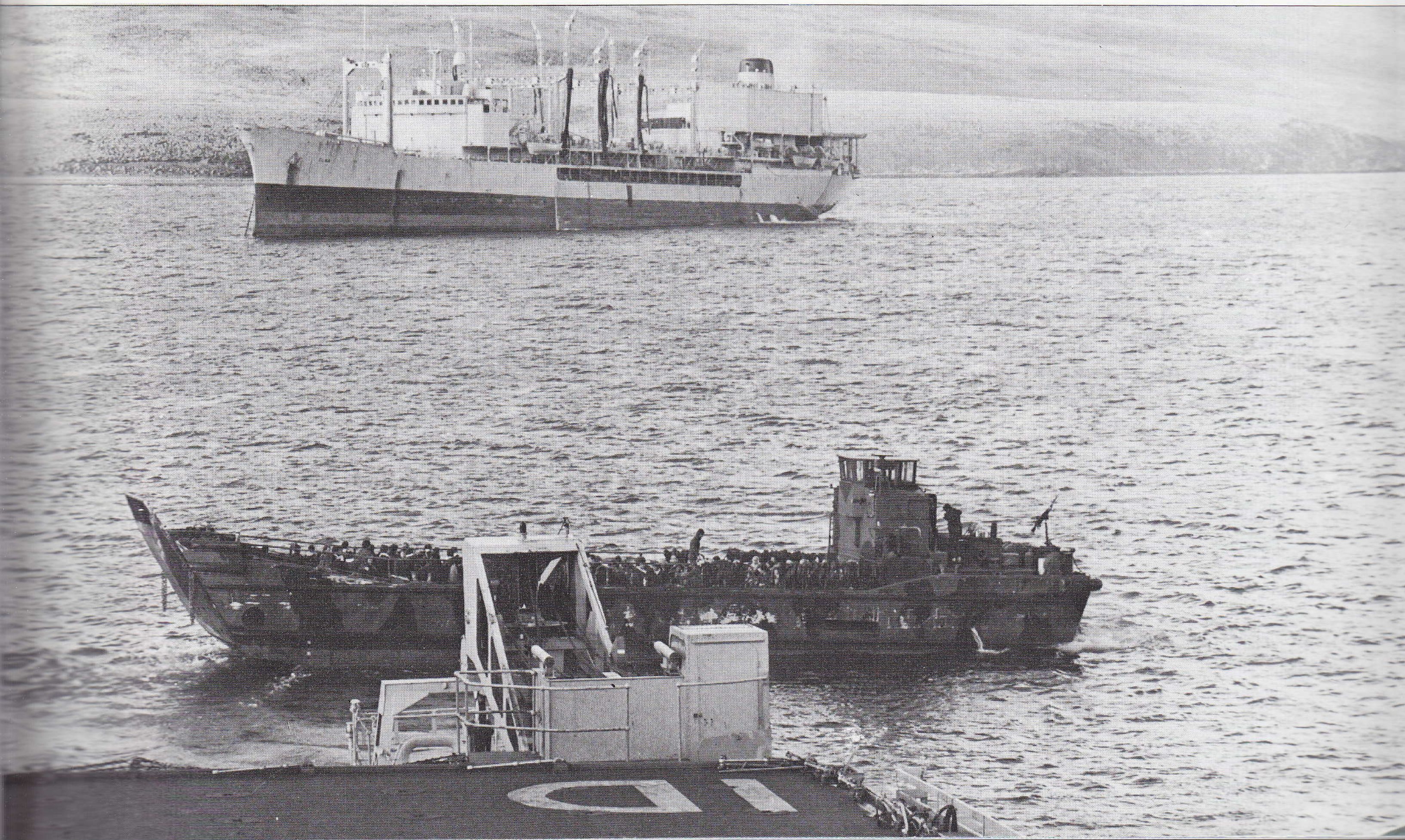
The Royal Navy has been a major advocate of SAM systems for the last 20 years, but the 1982 Falklands war re-emphasized the need for a balanced mix of air defence systems. Operating in the confines of San Carlos Water and its surrounds, the much-vaunted missile systems were hard pressed to keep at bay the low-level attacks made by the Argentine air force and naval air arm, largely because of the masking of the search and fire-control radars by the terrain and the ground returns that this caused on the screens. Thus, until the Rapier battery was established ashore the day after the landing, the main air defence of the fleet was left to the 114-mm (4.5-in) Mk 6 and Mk 8 medium guns, the 40-mm Bofors and 20-mm Oerlikons of the secondary armament, and the obsolete optically-guided Sea Cat SAM. Wherever possible these were supplemented by hastily contrived mountings for 7.62-mm (0.3-in) machine-guns, and the shoulder-launched Blowpipe SAM.

The fully automatic single-barrel 114-mm Mk 8 gun has an effective range of 22 km (13.67 miles) and can be fired at a maximum rate of 25 rounds per minute. Fitted with a Thorn EMI N97 multi-role fuse, the 21-kg (46.3-lb) shell can be armed for contact, delayed action or proximity detonation, the last being ideal for anti-aircraft fire as the 25-kg (5.5-lb) HE bursting charge in the shell produces over 3,000 metallic fragments when it explodes. A specialist chaff round can also be fired to confuse the search radars of attacking aircraft and radar-guided anti-ship missiles. The Mk 8 saw most service during the war in the shore bombardment role, although during the 21 May landings at San Carlos it was used in the air-defence role as well. Before she was sunk on that day the 'Type 21' HMS *Ardent* alone used some 190 rounds of 114-mm ammunition, five Sea Cat missiles and several hundred 20-mm rounds against the initial air raids by Grupo 3 FMA Pucaras and Grupo 6 IAI Daggers without any success, while on 30 May the 'Type 21' frigate HMS *Avenger* actually engaged and destroyed an AM.39 Exocet (aimed at the carrier group) with her Mk 8 guns at a range of 12.8 km (8 miles).

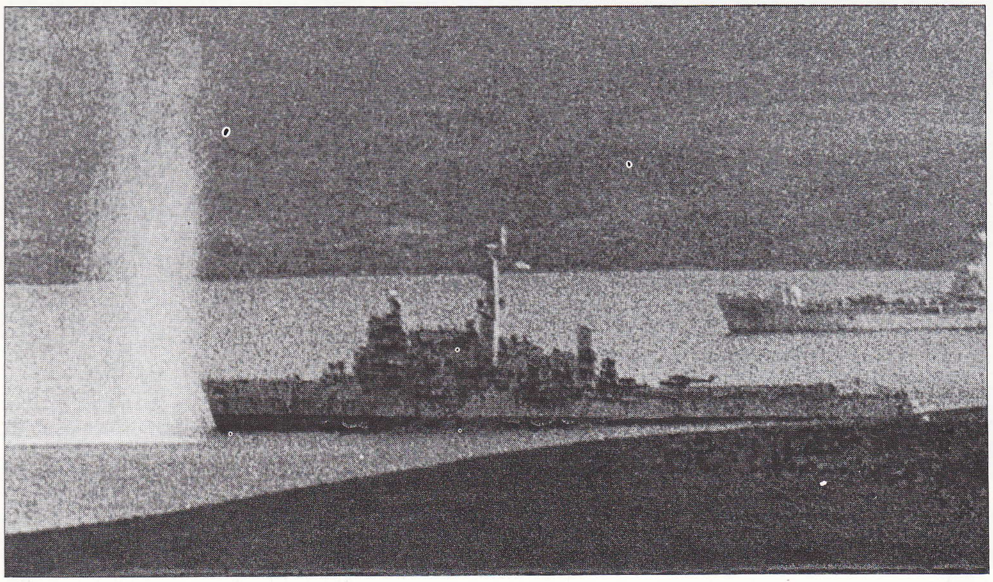
HMS *Plymouth* attack

The semi-automatic or manual twin Mk 6, with an earlier version of the 114-mm gun, has a lower performance using a 25-kg (55-lb) shell out to some 19 km (11.8 miles). Again mainly used for shore bombardment, in one air-surface action carried out on the 'Rothesay' class frigate HMS *Plymouth* on 8 June, the Mk 6 mounting could not be brought to bear on a line astern attack by five Grupo 6 Daggers which could only be met by firing 20-mm Oerlikons, small arms and several Sea Cat SAMs, none of which brought down the aircraft. The ship fortunately suffered only damage from four bombs which hit the superstructure but failed to detonate. The Mk 8 normally uses the WSA Mk 4 fire-control system with control effected from the below-decks operation room by joystick and the appropriate Action Information system, while the Mk 6 uses the elderly MRS3 system.

The 40-mm L/60 or L/70 Bofors is used on the two-man single-barrel Mk 7 and Mk 9 mountings. At one time both these (and a twin system) were the standard AA weapons of the fleet, but by the Falklands war they had been relegated to form the secondary armament of several missile-equipped classes such as the 'Type 22 Batch 1s' and 'Leanders'. The mountings are open to the elements and powered to give rapid training and following. Fire-control is either by the Type 1006 high-definition navigation and helicopter-control radar, or more commonly by the gyro-stabilized sights with speed rings on the mount. The HE ammunition used weighs some 2.4 kg (5.3 lb) and is proximity- or contact-fused; its lethality is nowhere near that of the new ammunition ranges produced by the Swedes to upgrade the weapons to counter anti-ship missile targets. Depending upon the length of the gun the effective range is either 3000 m (3,280 yards) or 4000 m (4,375 yards), which was of significant benefit in San Carlos Water. On 27 May Bofors fire from HMS *Fearless* or *Intrepid*, the two British assault ships, caused damage to the only aircraft which can categorically be stated to have been shot down by AA gunfire alone. The Argentine air force McDonnell Douglas A-4B Skyhawk from Grupo 5, piloted by Lieutenant Velasco, suffered such severe damage while overflying San Carlos Water on the way to attack a target at Ajax Bay that Velasco turned back and eventually ejected from his aircraft while over West Falkland.



Such was the shortage of close-range automatic weaponry during the Falklands conflict that the light machine-guns of the infantry were pressed into service as an ad hoc defence. The loaded LCU leaving the docking well of HMS Intrepid *has a GPMG pintle-mounted at the stern.*



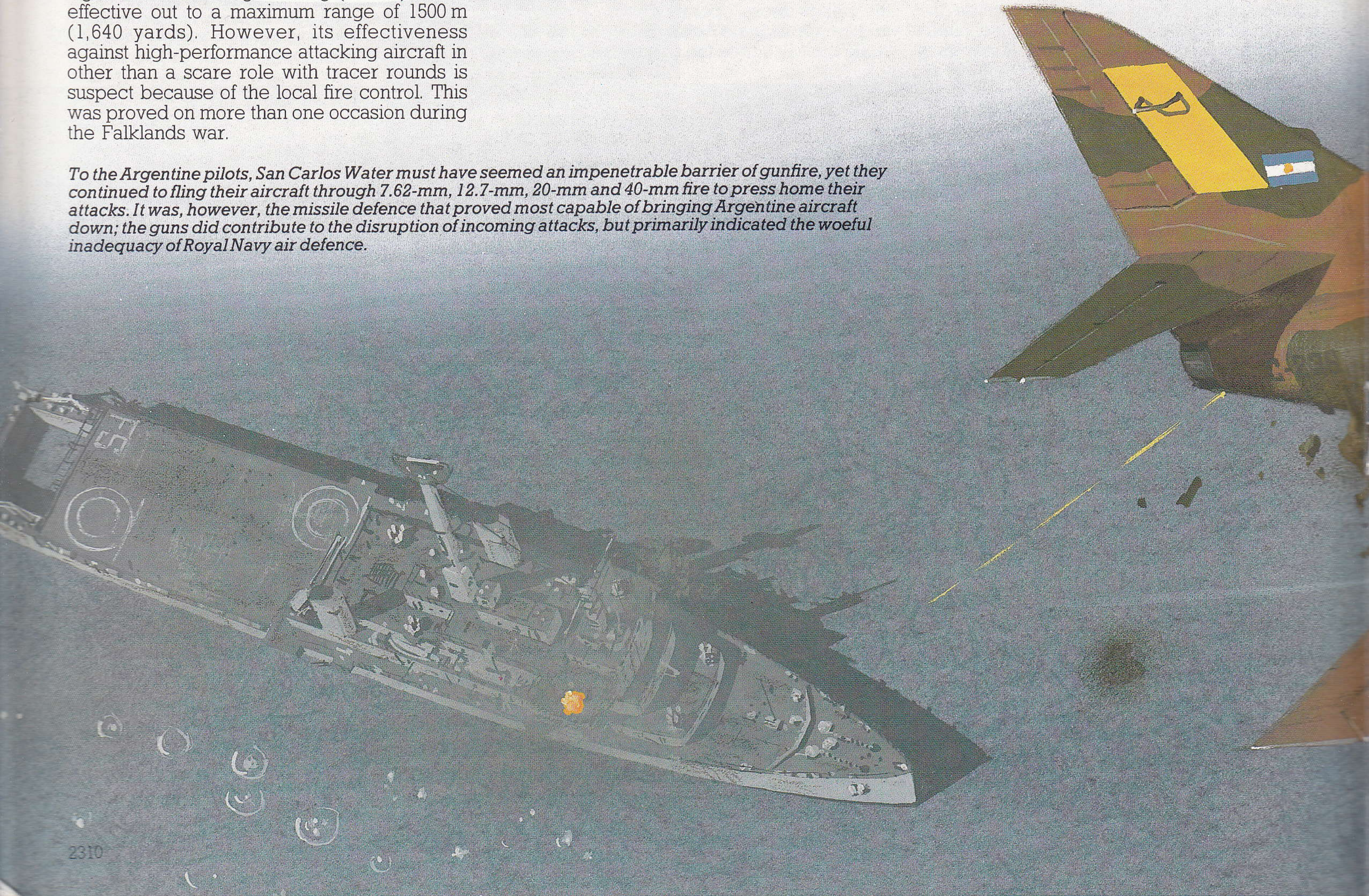
The courage of the pilots Argentina threw against the defences of the Royal Navy task force was evident from the start, and in the enclosed waters of San Carlos the ships in the landing force were subjected to repeated attack.

The main close-range gun was the ubiquitous 20-mm Oerlikon which originated from a Swiss design and had actually been declared obsolete in 1945. However, because of its light weight and robustness it stayed on with the fleet for use in the local surface defence and AA roles. In fact on a number of classes (such as the 'Type 21', 'Type 42' and 'County') it provided the only other gun armament apart from the 114-mm weapon. With a crew of one or two for an open pedestal mount, the gun is under local operator control with only a ring and bead sight. The shell weighs 0.4 kg (0.88 lb) and is effective out to a maximum range of 1500 m (1,640 yards). However, its effectiveness against high-performance attacking aircraft in other than a scare role with tracer rounds is suspect because of the local fire control. This was proved on more than one occasion during the Falklands war.

The final weapon in the air-defence artillery role on a number of ships was the 7.62-mm machine-gun in its L7A2 belt-fed GPMG and magazine-fed L4A4 LMG versions. With an effective range of between 800 and 1000 m (875 and 1,095 yards) and firing mixed loads of tracer and AP rounds, these weapons proved useful deterrent weapons. In fact during the final attack on the *Ardent*, by three A-4Q Skyhawks of the 3rd Naval Fighter and Attack Squadron, the ship's civilian canteen manager Petty Officer John Leake (an ex-army man given a naval rank for the duration of hostilities) managed to direct a burst from his LMG into the wing of the second Skyhawk (piloted by Lieutenant Jose Arca) puncturing its fuel tanks. Following a subsequent air battle with BAe Sea Harriers, in which his two companions were shot down and his aircraft suffered further damage in the vicinity of its landing gear, Arca decided to attempt an emergency landing at Port Stanley as the amount of fuel remaining was insufficient to regain either the mainland or a Lockheed KC-130H tanker aircraft. Once over the field Arca found that his landing gear would not lower because of the damage caused by the Sea Harriers' cannon fire, so he ejected, the aircraft crashing soon after into the sea just offshore.

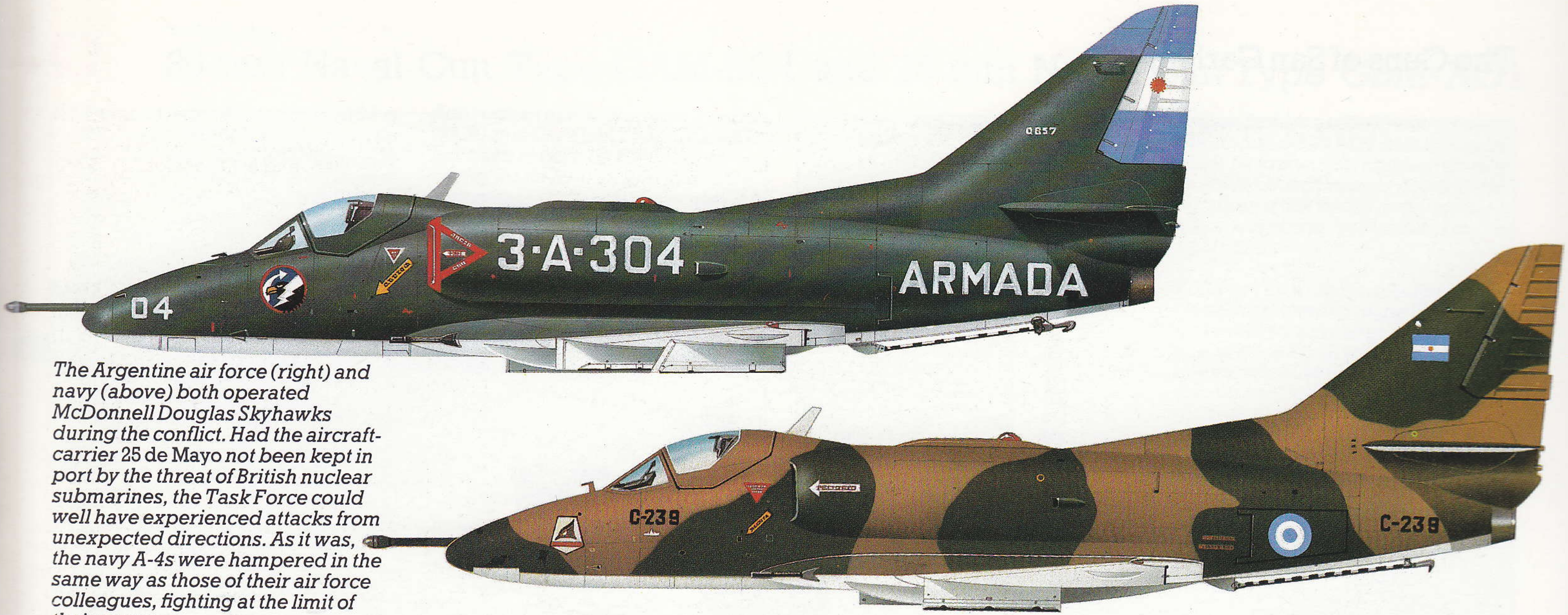
Overestimated kills

When Argentine losses are analysed against official British claims of 43 kills to missile and AA gunfire, serious doubts creep in. All available published evidence indicates that this



The only aircraft indubitably shot down by gunfire was a McDonnell Douglas A-4B Skyhawk from Grupo 5 of the Argentine air force. Piloted by Lieutenant Velasco, it was hit by 40-mm shells from one of the British assault ships and eventually crashed on West Falkland after Lieutenant Valasco ejected.

To the Argentine pilots, San Carlos Water must have seemed an impenetrable barrier of gunfire, yet they continued to fling their aircraft through 7.62-mm, 12.7-mm, 20-mm and 40-mm fire to press home their attacks. It was, however, the missile defence that proved most capable of bringing Argentine aircraft down; the guns did contribute to the disruption of incoming attacks, but primarily indicated the woeful inadequacy of Royal Navy air defence.



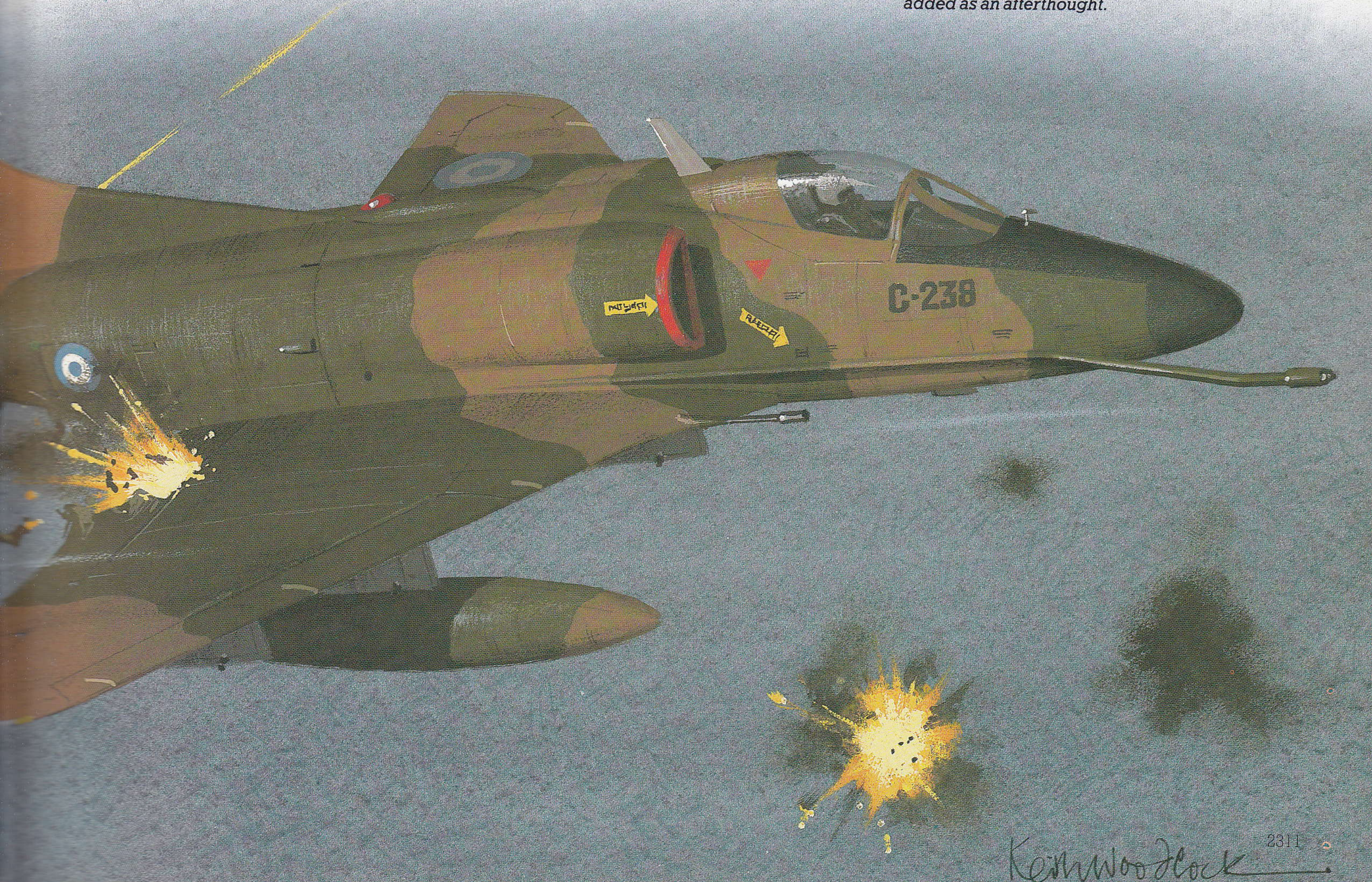
The Argentine air force (right) and navy (above) both operated McDonnell Douglas Skyhawks during the conflict. Had the aircraft-carrier 25 de Mayo not been kept in port by the threat of British nuclear submarines, the Task Force could well have experienced attacks from unexpected directions. As it was, the navy A-4s were hampered in the same way as those of their air force colleagues, fighting at the limit of their range.

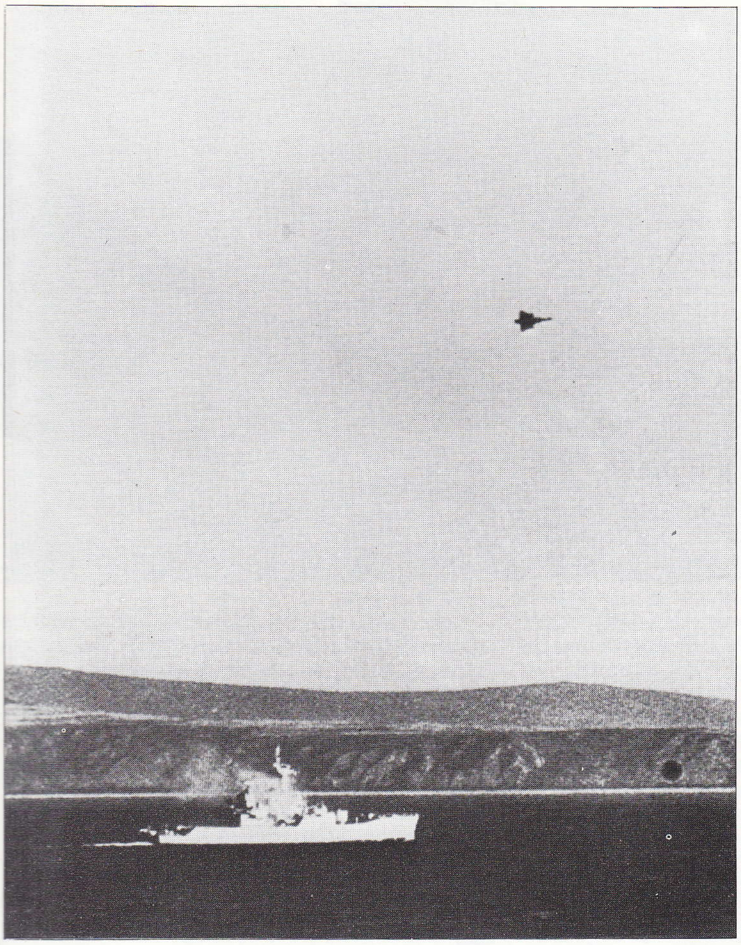
British claim is a gross overestimate. The guns may possibly have had a part with other weapons in some four other kills. These were an A-4B Skyhawk of Grupo 5 on 23 May, an A-4C Skyhawk of Grupo 4 on 24 May, and two more A-4C Skyhawks from the same *grupo* on the following day.

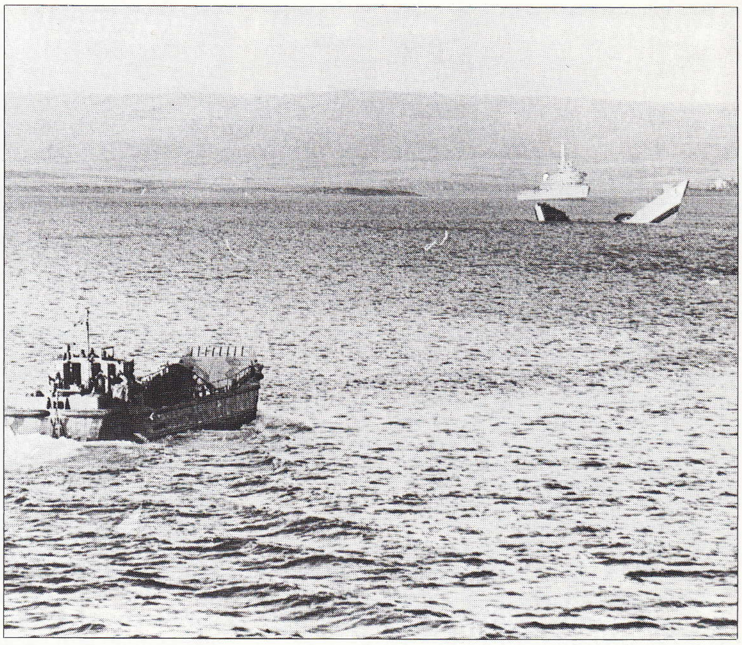
Whatever the actual losses, the war proved that the local air defence of British warships was woefully inadequate for modern naval warfare against jet aircraft and missiles. As a direct result ships hurriedly commissioned (after building or refits) to go to the South Atlantic after the war were fitted with extra AA firepower. In the case of the 'Type 42' air-defence vessels the ships' boats were sacrificed to fit two twin 30-mm GCM-AO3-2 mounts and two single 20-mm guns to supplement the two Oerlikons amidships. The carrier HMS *Illustrious* sprouted two 20-mm Phalanx CIWS before her departure. Subsequently most of the other warships had their close-in gun armament strengthened with either the 'Type 42' fit or the addition of extra 20-mm guns of one type or another. Practically all ships today have had the improvements made, most ships also having several special positions prepared for machine-guns.

For the future the Royal Navy is to instal a number of CIWS on its ships. The types chosen appear to be the 30-mm Goalkeeper and the Phalanx. The initial fit of the former will be to the 'Type 22 Batch 3s' and the new 'Type 23' or 'Duke' class frigates.

Argentine low-level attacks on the British fleet resulted in the loss of four ships; things might have been different had the Royal Navy attached greater importance to the gun as part of air defence. Their appreciation has risen greatly as a result of the conflict, with gun armament now seen to complement missile systems rather than being added as an afterthought.



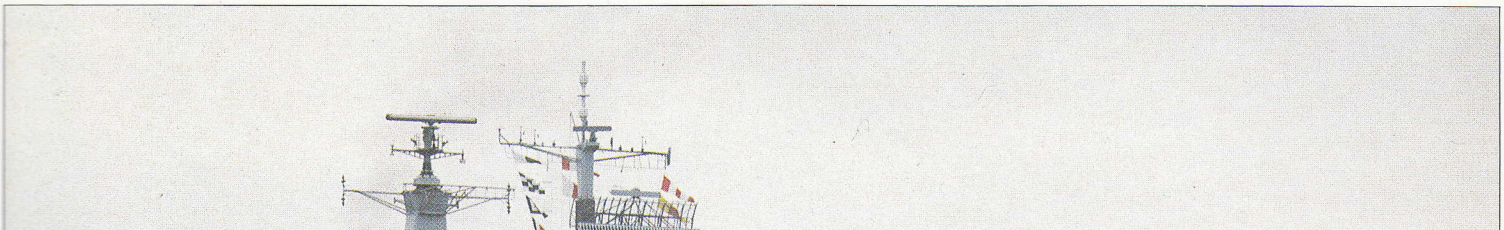




Left: An Argentine Dagger comes under fire from a 'Rothesay' class frigate in San Carlos Water. HMS Plymouth *of the class was hit by four bombs on 8 June, having only two 20-mms astern able to bear on the attack. Fortunately the bombs did not explode.*

Above: HMS Antelope *was not so lucky, however. Attacked on 23 May, she blew up on the following day while attempts were being made to defuse an unexploded bomb. The broken-backed wreck lay in San Carlos Water as mute testimony to the ferocity of the battle.*

Below: The lessons of the Falklands were soon learned. HMS Illustrious, *fitting out during the conflict, entered service with the Phalanx 20-mm CIWS and improved electronic and communication systems. One Phalanx can be seen forward by the twin Sea Dart launcher, and another on the stern.*



SWITZERLAND

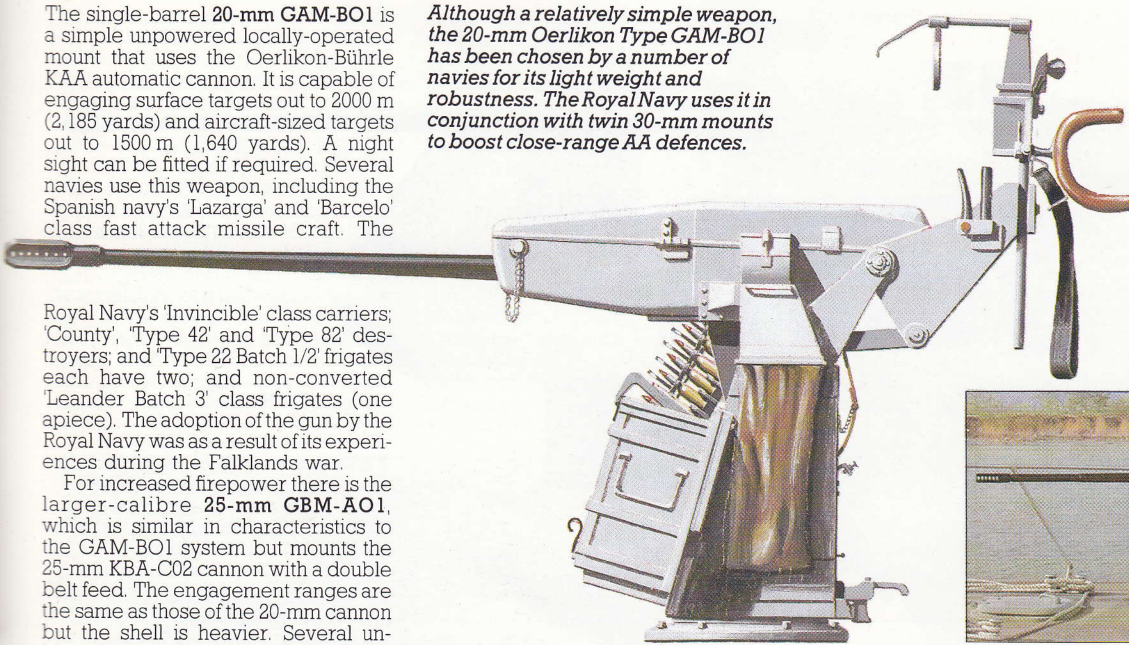
20-mm Naval Gun Type GAM-BO1 and 25-mm Naval Gun Type GBM-AO1

The single-barrel **20-mm GAM-BO1** is a simple unpowered locally-operated mount that uses the Oerlikon-Bührle KAA automatic cannon. It is capable of engaging surface targets out to 2000 m (2,185 yards) and aircraft-sized targets out to 1500 m (1,640 yards). A night sight can be fitted if required. Several navies use this weapon, including the Spanish navy's 'Lazarga' and 'Barcelo' class fast attack missile craft. The Royal Navy's 'Invincible' class carriers; 'County', 'Type 42' and 'Type 82' destroyers; and 'Type 22 Batch 1/2' frigates each have two; and non-converted 'Leander Batch 3' class frigates (one apiece). The adoption of the gun by the Royal Navy was as a result of its experiences during the Falklands war.

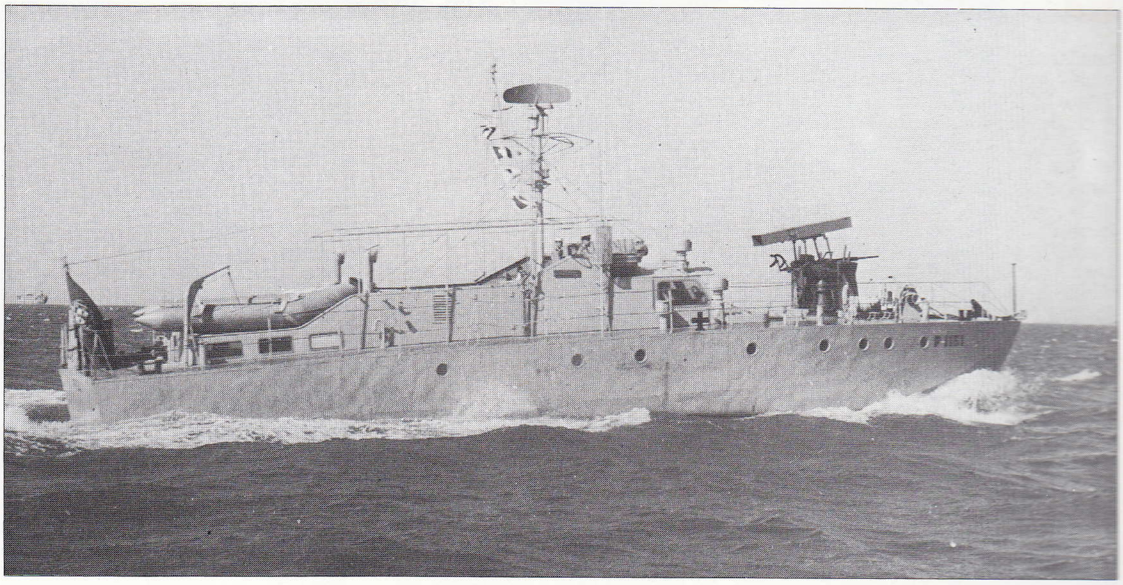
For increased firepower there is the larger-calibre **25-mm GBM-AO1**, which is similar in characteristics to the GAM-BO1 system but mounts the 25-mm KBA-C02 cannon with a double belt feed. The engagement ranges are the same as those of the 20-mm cannon but the shell is heavier. Several unidentified navies have adopted this weapon.

Specification
GAM-BO1
Calibre: 20 mm
Number of barrels: one
Elevation: −15° to +60°
Muzzle velocity: 1050 m (3,444 ft) per second
Effective range: see text
Rate of fire: 600 rounds per minute
Weight: (with ammunition) 500 kg (1,102 lb)
Number of rounds on mount: 200

Specification
GBM-AO1
Calibre: 25-mm
Number of barrels: one
Elevation: −15° to +50°
Muzzle velocity: 1100 m (3,609 ft) per second
Effective range: see text
Rate of fire: 570 rounds per minute
Weight: (with ammunition) 600 kg (1,323 lb)
Number of rounds on mount: 200


Although a relatively simple weapon, the 20-mm Oerlikon Type GAM-BO1 has been chosen by a number of navies for its light weight and robustness. The Royal Navy uses it in conjunction with twin 30-mm mounts to boost close-range AA defences.

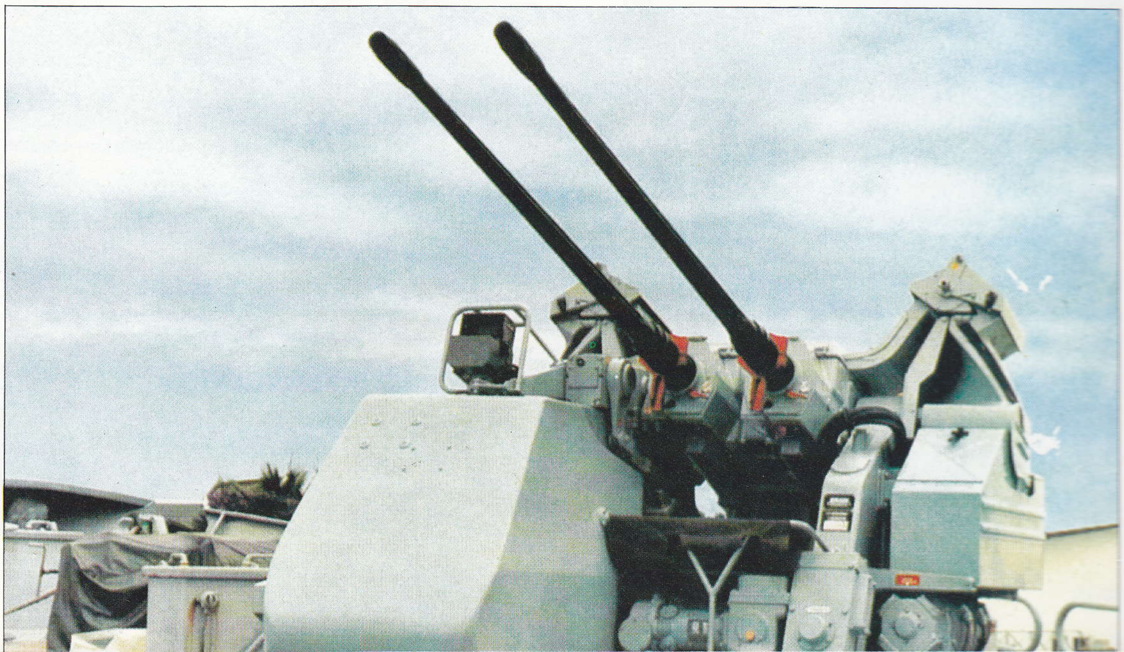
Below: Similar to the 20-mm weapon, the 25-mm GBM-A O1 fires a heavier shell. Its low weight makes it simple to instal aboard vessels down to the smallest of fast patrol craft, and no electrical power is required for operation.


Bottom: The widely-used 20-mm Oerlikon mounting of the World War II manual type is still in production and service worldwide. A more modern cannon and ring sighting system has been fitted, as on this gun in service with the Angolan navy aboard an ex-Portuguese 'Bellatrix' class patrol vessel.

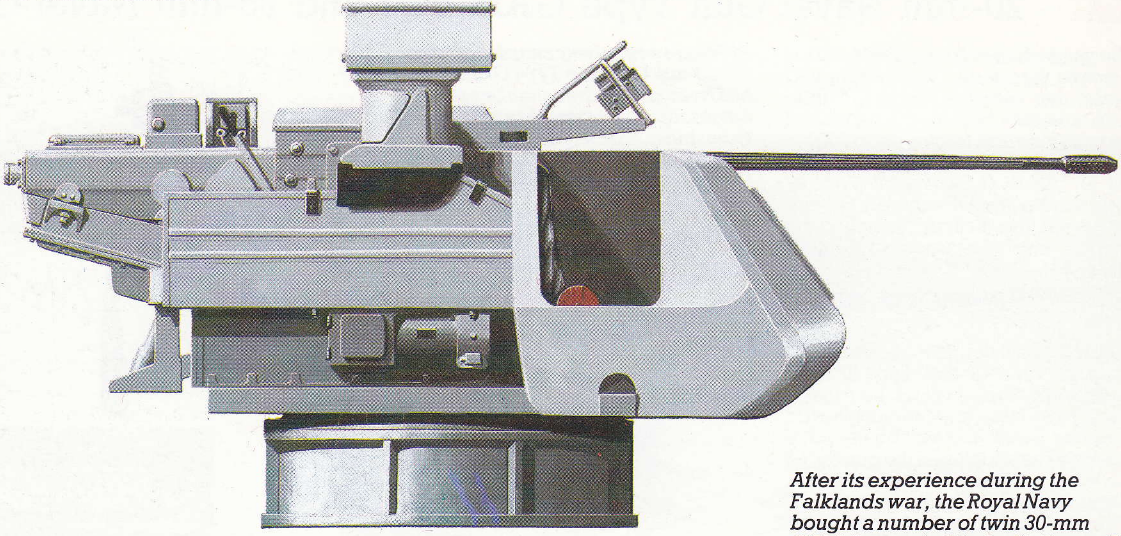
SWITZERLAND

30-mm Twin Anti-Aircraft Gun Type GCM-A

The Oerlikon-Bührle **30-mm Type GCM-A** is produced in three different versions: the **GCM-AO3-1** with an enclosed gunner's position, stabilized control and optional remote control from a fire-control system; the **GCM-AO3-2** which is essentially the same as the GCM-AO3-1 but with an open gunner's position; and the **GCM-AO3-3** without a gunner's position and thus fitted only for remote control. The 30-mm KCB cannon used in the GCM-AO3 is also used in the American twin 30-mm EMERLEC-30 and the British Laurence Scott (Defence Systems)


As is increasingly common, the GCM-A has been designed for fitment to small surface vessels. The model AO3-2, with an open gunner's station, weighs only 2560 kg (5,644 lb) complete, and can be operated both locally and with remote control.

single-barrel LS30B systems. As a direct result of the lack of close-range air-defence guns during the Falklands war, to augment secondary armament the Royal Navy purchased a number of licence-built GCM-AO3-2 mounts from the British company BMARC for fitting to its sole 'Type 82' destroyer and the 12 'Type 42' destroyers remaining after HMS *Sheffield* and *Coventry* had been sunk. Unfortunately in the case of the 'Type 42s' the ships' boats have had to be removed in order to incorporate the two mountings required and prevent top-heaviness. A number of other navies are in the process of evaluating the mounts and are expected to place orders.



After its experience during the Falklands war, the Royal Navy bought a number of twin 30-mm GCM-A mounts fitted with Ferranti gyroscopic lead angle computing sights from BMARC Ltd to supplement its close-range anti-aircraft armament.

Specification

Type GCM-A
Calibre: 30 mm
Number of barrels: two
Elevation: −10° to +75°
Muzzle velocity: 1080 m (3,543 ft) per second
Effective range: 3000 m (3,280 yards)
Rate of fire: 1,300 rounds per minute
Weight: (with ammunition) GCM-AO3-1 2910 kg (6,415 lb), GCM-AO3-2 2515 kg (5,545 lb) and GCM-AO3-3 2560 kg (5,644 lb)
Number of rounds carried on mount: GCM-AO3-1/2 500, and GCM-AO3-3 640

SWITZERLAND

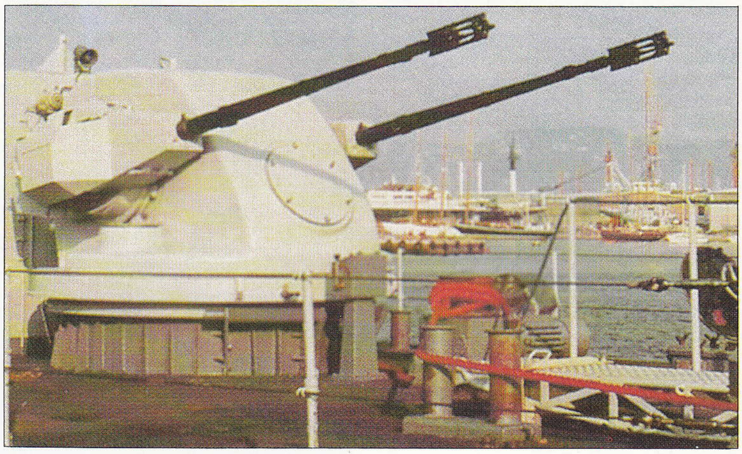
35-mm Twin Anti-Aircraft Gun Type GDM-A

Similar in concept and design to the highly successful Oerlikon twin 35-mm Type GDF land-based anti-aircraft guns, the naval **35-mm Type GDM-A** is intended primarily for use against air attacks, but if required can also be used to engage surface targets at sea and on land. The stabilized mount is an all-weather system with its electronic control units located below decks. The cannon fitted are of the KDC model, which are fully automatic in operation. The turret has three possible modes of use: fully automatic with control exercised from either a below-decks fire-control system or an upper-deck optical aiming unit fitted with an auxiliary computer; local operator control with the gunner using a joystick and gyro-stabilized gunsight; and emergency manual control using two hand wheels and the gunsight when power to the mount is cut. Each of the cannon has 56 ready-use rounds, with another 224 rounds in total reserve. At least five countries use this turret on their warships, namely Ecuador, Greece, Iran, Libya and Turkey.

Specification

Type GDM-A
Calibre: 35 mm
Number of barrels: two
Elevation: −15° to +85°
Muzzle velocity: 1175 m (3,855 ft) per second
Effective range: 3500 m (3,830 yards)
Rate of fire: 1,100 rounds per minute
Weight: (with ammunition) 6520 kg (14,374 lb)
Number of rounds on mount: 336

Below: Produced as a private venture by OTO-Melara, the twin 35-mm OE/OTO mount uses the Oerlikon KDA 35-mm gun, which is similar to the KDC gun employed in the Swiss company's Type GDM-A system. At present only the Libyan navy has bought the mount for its 'Assad' class missile corvettes.



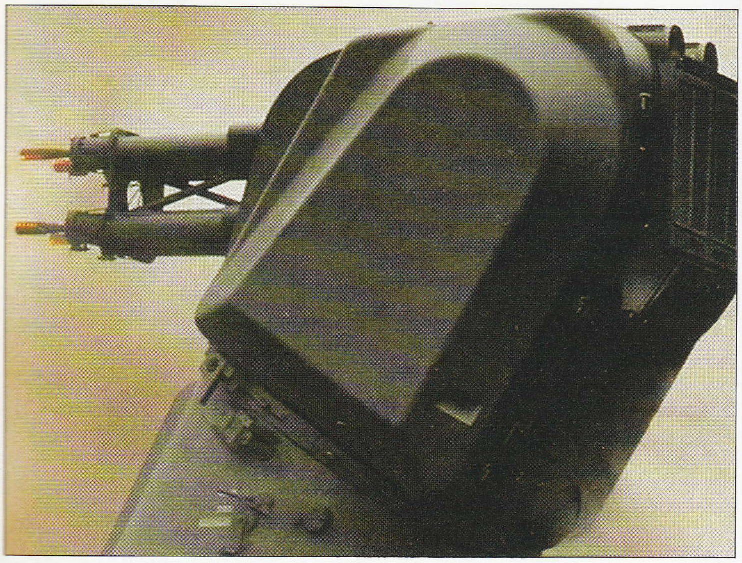
Above: The original Oerlikons were largely used as naval weapons, but the 35-mm KDC cannon used in the GDM-A is derived from a towed weapon developed in the late 1950s. The Italian model, known to Oerlikon as the GDM-C, uses a slightly heavier variant.

ITALY/SWITZERLAND/UK

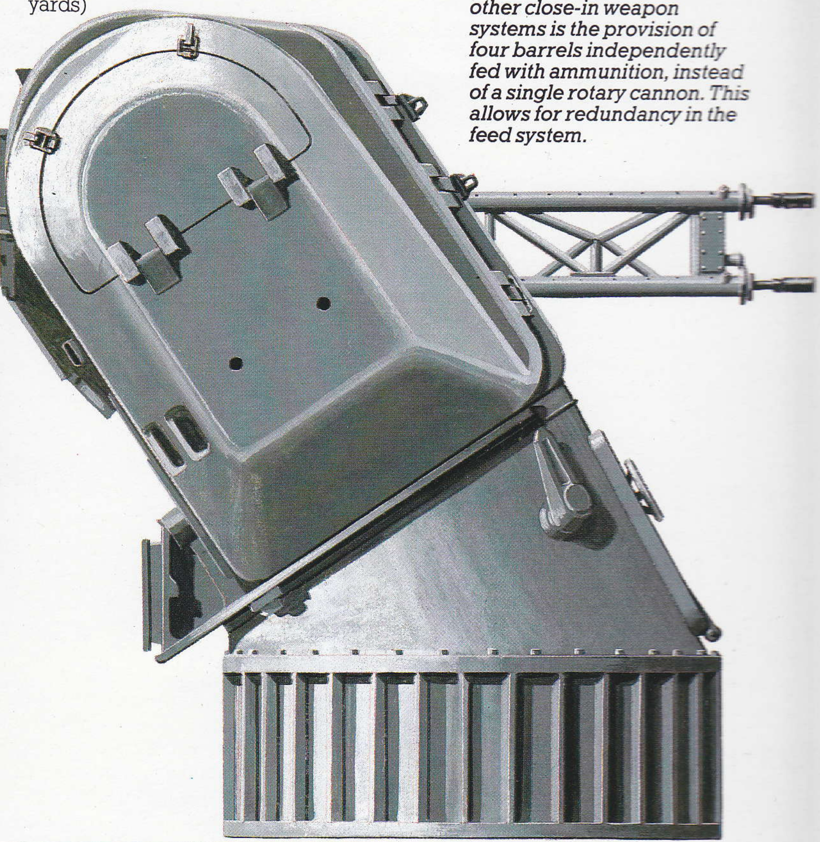
25-mm Seaguard Close-in Weapon System

The **25-mm Seaguard CIWS** naval air-defence system is an international project between countries from Italy, Switzerland and the United Kingdom. It consists of an above-decks tracker module, an independent search radar, a GMB-B1Z Sea Zenith mount with four KBB-R04/404 cannon, and a below-decks ammunition feed and operator's console with associated electronics. The sensor unit is fitted with a K-band radar, a forward-looking infra-red (FLIR) system and a laser sensor for the acquisition of missile-sized targets. Each of the cannon is independently fed from the below-decks ready-use supply, where sufficient rounds are available to engage 18-20 different targets without reloading. Typical engagement ranges are from 1500 m (1,640 yards) down to 100 m (109 yards) against missiles and out to a maximum of 3500 m (3,830 yards) against aircraft. Ammunition types fired include an HE-incendiary round and a new Anti-Missile Discarding-Sabot (AMDS) round. If required the mount can be elevated to +127° to cover steep-diving targets. Three Seaguard CIWS systems are being fitted to each of the four 'MEKO 200' frigates being built at present for the Turkish navy.

Below: The first navy to adopt the 25-mm Seaguard CIWS is that of Turkey, which has ordered sufficient to arm four frigates currently under construction. Enough ammunition is provided on-mount to engage 14 targets without reloading.



Specification
Seaguard
Calibre: 25 mm
Number of barrels: four
Elevation: −20° to +127°
Muzzle velocity: 1355 m (4,446 ft) per second
Effective range: 100-3500 m (109-3,830 yards)
Rate of fire: 3,400 rounds per minute
Weight: (with ammunition) 5700 kg (12,566 lb)
Number of rounds carried on mount: 1,660



The obvious difference between Seaguard and most other close-in weapon systems is the provision of four barrels independently fed with ammunition, instead of a single rotary cannon. This allows for redundancy in the feed system.

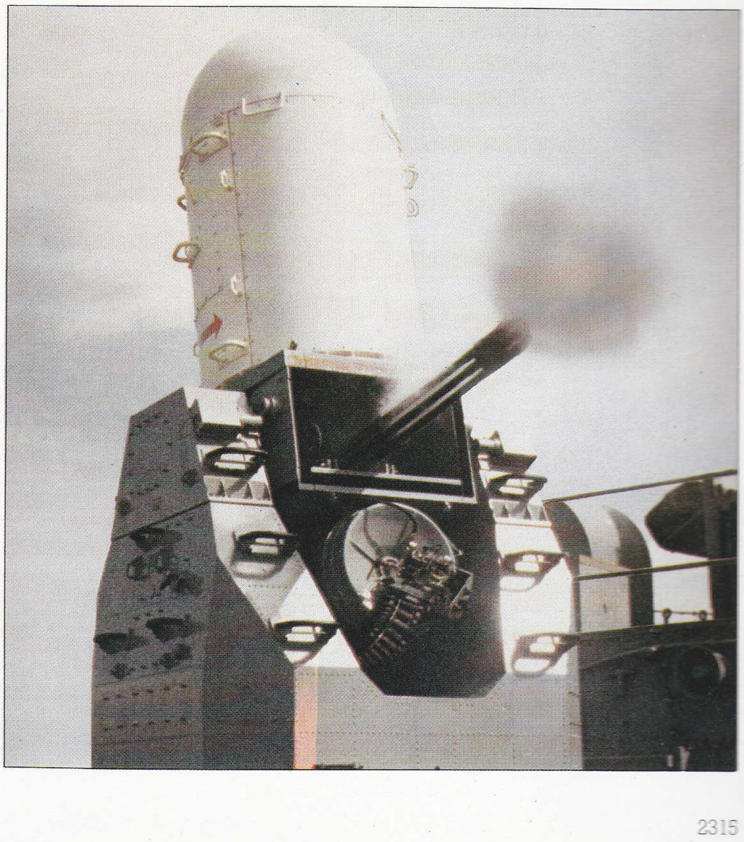
USA

20-mm Mk 15/16 Phalanx Close-In Weapon System

The General Dynamics Corporation **20-mm Phalanx Mk 15/16 CIWS** is a total weapons system which automatically carries out search and detection, target threat evaluation, tracking and firing against high-performance anti-ship missiles and aircraft as a 'last-ditch' defence. The Phalanx is built around the General Electric 20-mm M61A1 six-barrel 'Gatling' gun, and is hydraulically powered. Production started in late 1977, the first operational units being installed aboard the aircraft-carriers USS *Enterprise* and *America* during 1980. Current plans are for the US Navy to fit some 400 or more mounts in more than 250 ships, with frigates having only a single system and the 'Iowa' class battleships four. In order to enhance the Phalanx's capabilities a product-improvement programme is under way to increase the search-area and target-detection performance, and to provide for greater flexibility. By the end of 1984 220 Phalanxes had been installed aboard 125 US Navy ships, while a further 52 had been supplied to foreign buyers. Amongst the navies known to have Phalanx either in service or on order are those of Australia, Canada, Israel, Japan, Saudi Arabia and the UK. In the case of the last the systems were apparently ordered before the Falklands war for the 'Invincible' class carriers, with the first delivery being accelerated to equip HMS *Illustrious*. At present the *Invincible* and *Illustrious* carry two, while the newly completed *Ark Royal* has three. In live firing trials undertaken by the US Navy and the Royal Navy the Phalanx has proved capable of detecting and destroying MM.38 Exocet anti-ship missiles that may threaten Royal Navy ships in any future conflict in the South Atlantic.

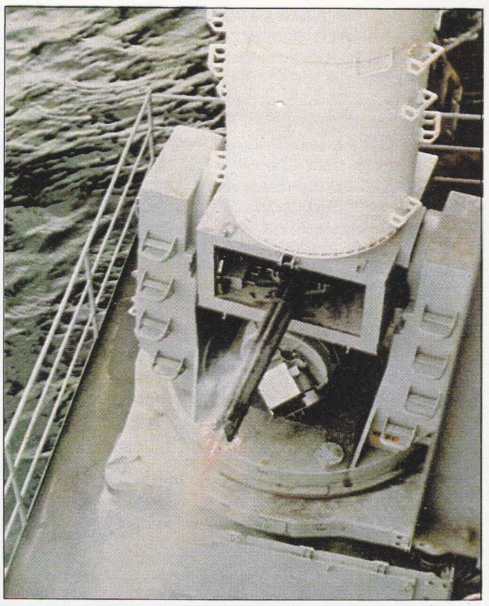
Specification
Phalanx Mk 15/16
Calibre: 20 mm
Number of barrels: six
Elevation: −25° to +80°
Muzzle velocity: 1097 m (3,600 ft) per second
Effective range: 500-1500 m (545-1,640 yards)
Rate of fire: 3,000 rounds per minute
Weight: (with ammunition) 6092 kg (13,430 lb)
Number of rounds on mount: 1,000 (latest Block 1 version is believed to have 1,400-1,600)

The General Dynamics Phalanx uses a 20-mm six-barrel Gatling gun with magazine and integrated fire control radars on the same mount to produce a single modular weapon system package. It is fully automatic in operation, but manual override is possible.



Phalanx in Action

One of the most important weapon systems in service in the West employs a gun originally developed in the late 1950s for use in the Lockheed F-104 Starfighter aircraft. Phalanx is a complete, self-contained anti-missile/aircraft system capable of detecting and destroying incoming missiles, even the sea-skimming Exocet.



Above: Phalanx fires a high kinetic energy penetrator made out of high-density metals such as uranium (in the case of the United States Navy) and tungsten (for foreign navies). This ensures premature explosion of any incoming warhead hit.

Right: British experience in the Falklands has shown that incoming missiles can often be decoyed, but enough might get through to make a close-in defence necessary. HMS Invincible *is fitted with Phalanx next to the Sea Dart launcher forward and on the flight deck aft.*

Below: The most powerfully-armed and armoured surface vessel in the world, the 'New Jersey' class is invulnerable to conventional missiles. Nuclear-tipped missiles are a real threat, however, which makes the four Phalanx systems so far fitted of real importance.

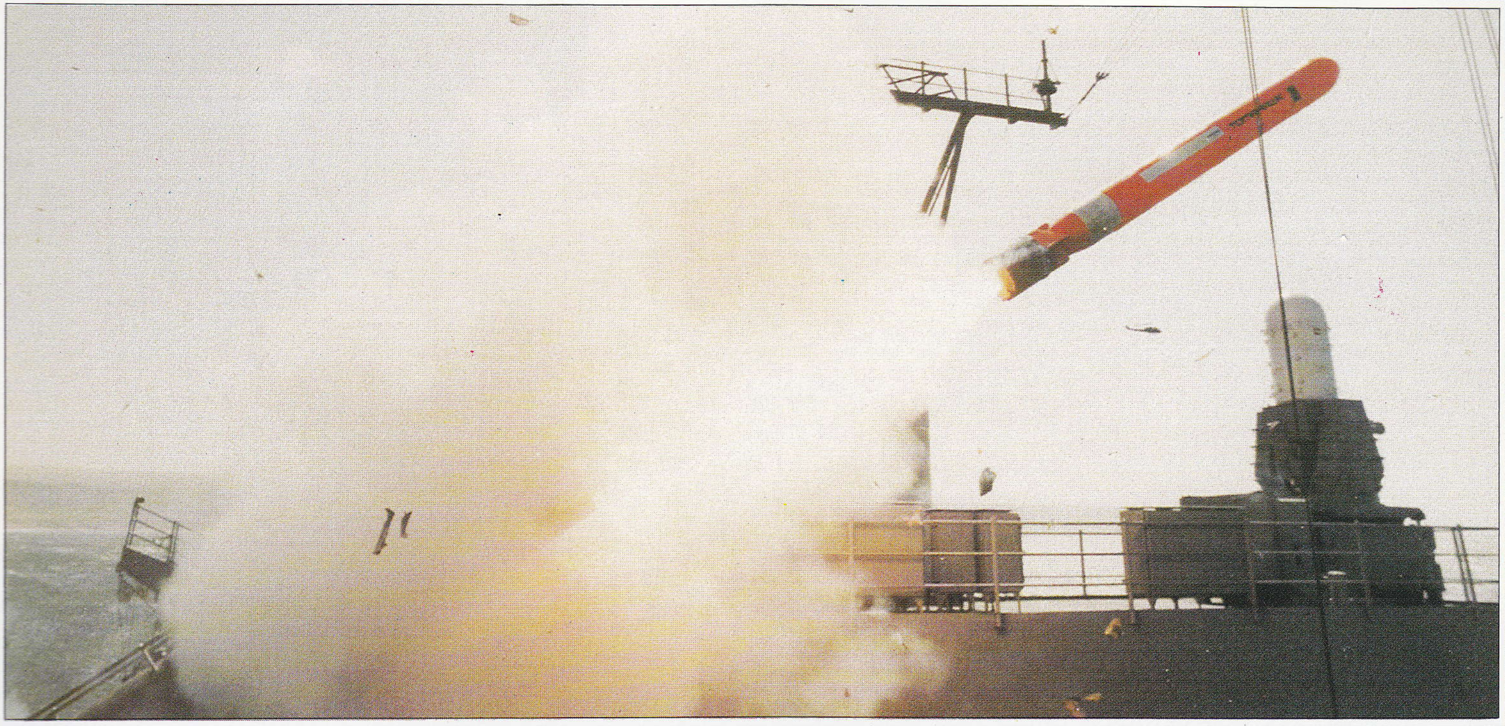
In the 1960s the US Navy sought to find a simpler Close-In Weapon System (CIWS) than the Sea Sparrow SAM. The basic requirement of such a system is that it should destroy attacking aircraft and anti-ship missiles that have leaked through the fleet's outer defences of fighter aircraft and medium- and long-range area-defence SAMs. The reponse to this request was the Phalanx gun system, which was the object of a feasibility study awarded to General Dynamics Pomona Division in 1969. It then took 11 years for operational weapons to be fitted to surface combatants.

The requirement the US Navy placed on Pomona was for a high individual lethality and for a very fast reaction time, with coincident high probability of hitting the target. To achieve the high rate of fire needed, Pomona chose a modified version of the proven 20-mm calibre M61 six-barrel 'Gatling' gun used on aircraft. The high round-lethality was more difficult, as from the outset a new round (using high kinetic energy to destroy or to cause premature detonation of the incoming warhead) had to be developed. Known as the Mk 149, this round has a depleted uranium penetrator manufactured from the waste products of nuclear reactor fuels. The penetrator is 2.5 times heavier than a comparable steel one, and has a diameter of only 12.7 mm (0.5 in). It is fired in a nylon sabot with an aluminium pusher that imparts spin to the projectile. Both the sabot and pusher break away after firing, leaving the penetrator with almost all the initial muzzle velocity of around 1097 m (3,600 ft) per second. This high speed (and the round's subsequent flat trajectory) allows for a simple fire-control solution.

This is based on the closed-loop spotting fire-control concept developed by Pomona, and which at a single stroke considerably improves system accuracy and minimizes reaction time required for target engagement. The two inbuilt J-band pulse-Doppler VPS-2 radar antennae colocate the search and track functions on a shared transmitter in the long cylindrical dome mounted atop the 'Gatling' gun. In the closed-loop situation the radars simultaneously track both the outgoing bursts of fire and the incoming target, the angular error between the two being calculated on the digital computer and the result used to correct the direction of the next burst. Thus the accuracy increases as the target approaches, the maximum lethality being achieved at a range of some 457 m (500 yards). The maximum effective range is some three times this distance.

Automatic operation

The entire Phalanx assembly, which is some 4.57 m (15 ft) high and 6092 kg (13,430 lb) in weight, moves as a single unit and is capable of defeating both diving and sea-skimming anti-ship missiles. Under normal conditions it operates automatically to detect and engage incoming high-speed targets unless an override button is pressed. If required the Phalanx can also accept target-designation data from external sources or, under the control of a fire-control system, engage small surface craft. With a 1,000-round magazine capacity on the early production systems, up to five separate targets



The range of weaponry aboard the rejuvenated battleships, from nuclear-tipped Tomahawk cruise missiles to the last line of defence that is Phalanx, give the class a fighting capacity undreamed of when they were launched in the 1940s.

can be engaged and destroyed. The actual time between identifying the threat and opening fire averages two seconds. For foreign military sales the depleted uranium penetrator can be replaced by a tungsten type.

The history of the development of the gun is a good example of the US procurement system in having to satisfy a sceptical Congress defence committee as to its availability and operational capabilities. The closed-loop spotting concept was initially demonstrated in 1970 at the White Sands Missile Range, together with the lethality of the depleted uranium round. Full-scale engineering development subsequently started later in that year, and a prototype unit successfully destroyed simulated threat missiles in the following year. The first seaborne unit went to sea during 1973-4 aboard the frigate USS *King*. In 1975 a further unit was installed aboard the hulk of the destroyer *Cunningham* and warshot missiles were fired against it: every weapon, including a Walleye glide bomb, was destroyed at a distance sufficient to ensure the ship's survival. In the following year the USS *Bigelow* shipped an operational pre-production model which over the next two years proved its capability to operate successfully in the presence of intense jamming, and to distinguish missile-size targets from the background clutter of nearby islands.

Full service use

The Phalanx was finally approved for full service use in 1977, the first production units being installed three years later aboard the aircraft-carriers USS *America* and *Enterprise*. Current US Navy plans for Phalanx deployment are that each carrier will have three, each major amphibious warfare vessel, missile cruiser and large destroyer two, and every frigate one. In addition the larger naval auxiliaries such as fleet oilers, fast combat support ships, replenishment oilers and ammunition ships will also receive two Phalanxes apiece and the 'Iowa' class battleships will each have four.

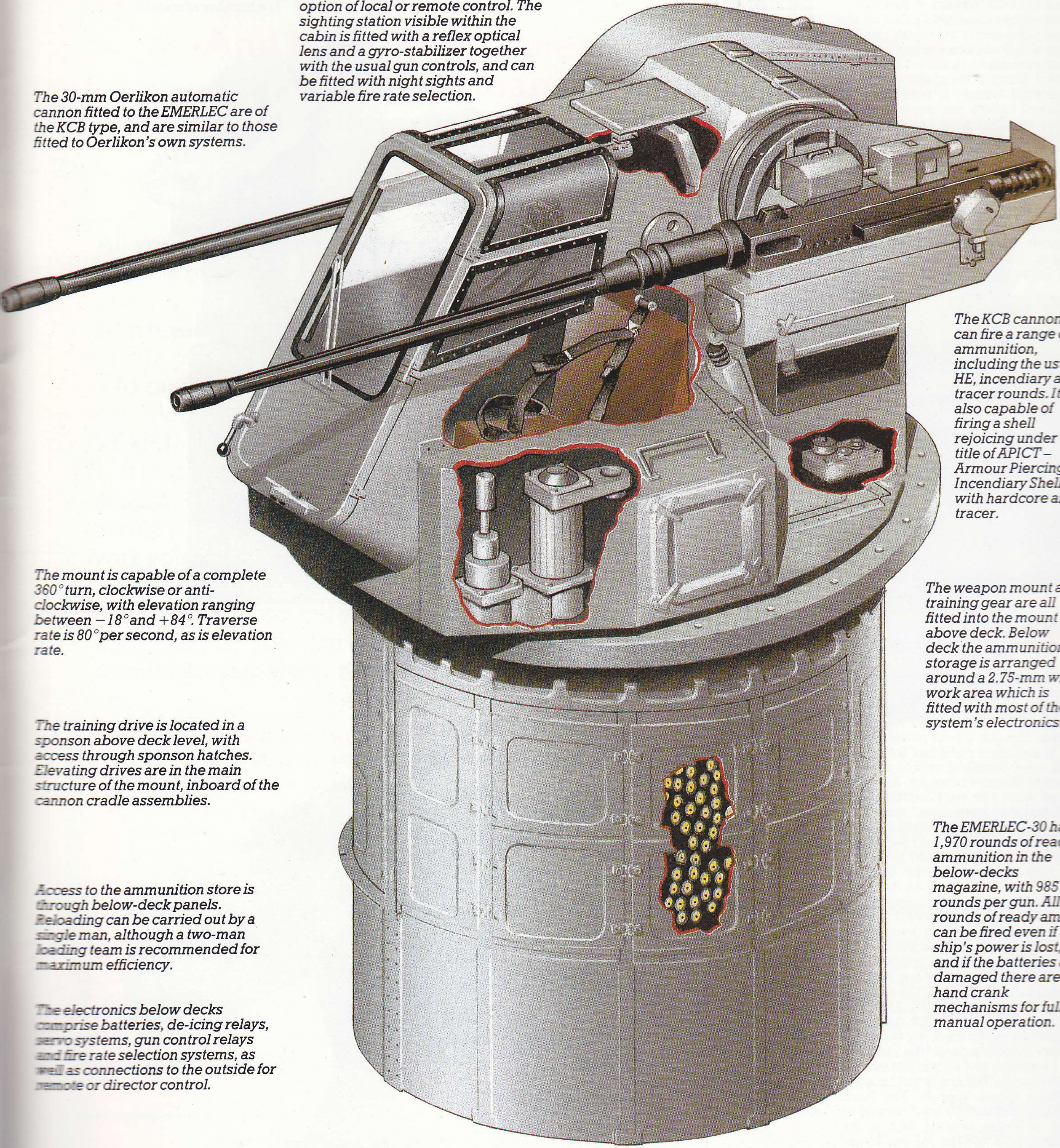
The first foreign sales were made to Japan, which started equipping her warships from 1981 onwards. Additional sales have since been made to the navies of Australia, Canada, Israel, Saudi Arabia and the UK. In the case of the last, the acquisition was partly the result of the experience gained in the 1982 Falklands war. Both Israel and Saudia Arabia have used their Phalanxes to provide the main anti-aircraft and missile defences for missile-armed patrol boats and corvettes. For Israel this includes defence against both Soviet SS-N-2A and SS-N-2B 'Styx' and Western Otomat and Exocet anti-ship missiles.

To improve the Phalanx further, an updated version with more ready-use rounds and the choice of two firing rates entered service in 1983. The older guns will be upgraded to this standard as they go in for overhaul. For the future it is planned that the search-area and target-detection performance will be enhanced, while the mean time-between-failure will be increased to improve system reliability and availability. It is also possible that a switch to a 30-mm calibre cannon will be made for greater lethality.

Mounted amidships on the cruiser USS Ticonderoga, *the Phalanx CIWS provides the last-ditch barrier in the carrier battle group's concentric series of defences against Soviet anti-ship missiles.* Ticonderoga *is a high-value target, being the heart of the AEGIS system.*

USA

EMERLEC-30 Twin 30-mm Mounting



The operator's cabin of the EMERLEC is environmentally controlled, with windscreen demisting and the option of local or remote control. The sighting station visible within the cabin is fitted with a reflex optical lens and a gyro-stabilizer together with the usual gun controls, and can be fitted with night sights and variable fire rate selection.

Access to the operator's cabin is between the cannon cradle assembly.

The 30-mm Oerlikon automatic cannon fitted to the EMERLEC are of the KCB type, and are similar to those fitted to Oerlikon's own systems.

The KCB cannon can fire a range of ammunition, including the usual HE, incendiary and tracer rounds. It is also capable of firing a shell rejoicing under the title of APICT – Armour Piercing Incendiary Shell – with hardcore and tracer.

The mount is capable of a complete 360° turn, clockwise or anti-clockwise, with elevation ranging between −18° and +84°. Traverse rate is 80° per second, as is elevation rate.

The weapon mount and training gear are all fitted into the mount above deck. Below deck the ammunition storage is arranged around a 2.75-mm wide work area which is fitted with most of the system's electronics.

The training drive is located in a sponson above deck level, with access through sponson hatches. Elevating drives are in the main structure of the mount, inboard of the cannon cradle assemblies.

Access to the ammunition store is through below-deck panels. Reloading can be carried out by a single man, although a two-man loading team is recommended for maximum efficiency.

The EMERLEC-30 has 1,970 rounds of ready ammunition in the below-decks magazine, with 985 rounds per gun. All rounds of ready ammo can be fired even if ship's power is lost, and if the batteries are damaged there are hand crank mechanisms for fully-manual operation.

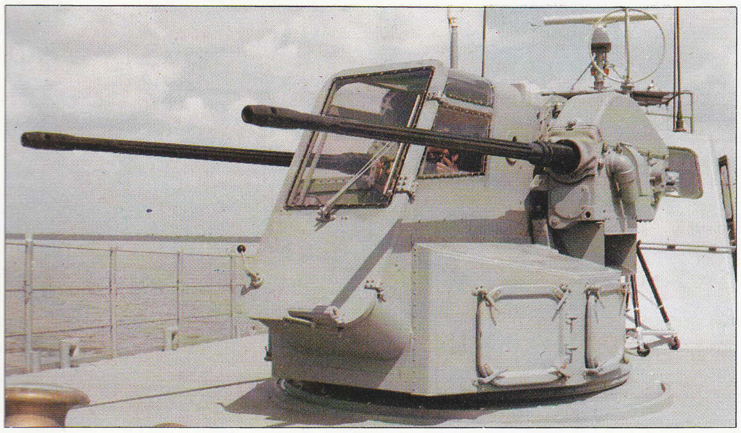
The electronics below decks comprise batteries, de-icing relays, servo systems, gun control relays and fire rate selection systems, as well as connections to the outside for remote or director control.

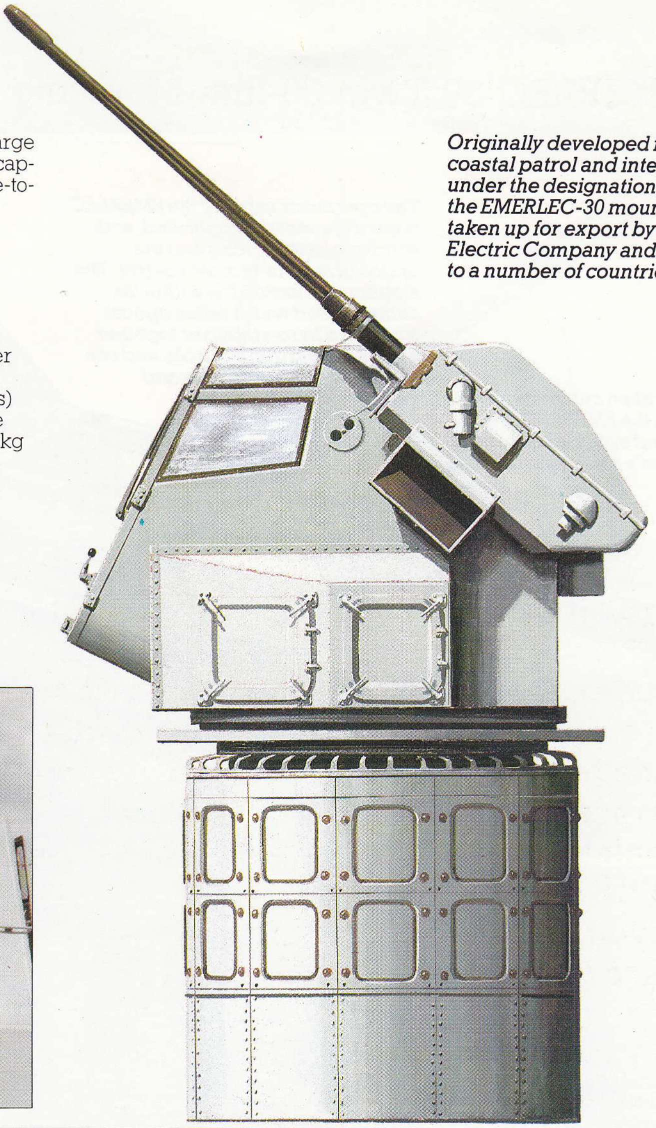
EMERLEC-30 Twin 30-mm Mounting (continued)

Designed and built by the Emerson Electric Company, the **EMERLEC-30 Twin 30-mm Mounting** was originally developed as the **EX-74 Mod O** for the US Navy to use aboard coastal patrol and interdiction craft. Based on two Oerlikon KCB cannon it has an environmentally controlled cabin for the gunner, day and/or night sights, and an integral below-decks magazine. The mount can also be operated by remote control using a standard shipboard fire-control system. In emergency an on-mount battery can provide all the power required to operate the guns and fire the full complement of ready-use ammunition carried. Manual gun controls are also fitted to provide further back-up if the battery fails. The mount has been in series production since 1976 and is known to be in service with the navies of Colombia, Ecuador, Ethiopia, Greece, Malaysia, Nigeria, the Philippines, South Korea and Taiwan. In most cases the fit has been to missile attack craft or large patrol boats. The mounting is also capable of being used in the surface-to-surface role.

Specification
EMERLEC-30
Calibre: 30 m
Number of barrels: two
Elevation: −15° to +80°
Muzzle velocity: 1080 m (3,543 ft) per second
Effective range: 3000 m (3,280 yards)
Rate of fire: 1,200 rounds per minute
Weight: (without ammunition) 1905 kg (4,200 lb)
Number of rounds on mount: 1,970

Below: Designed for anti-missile, anti-aircraft and surface fire, the EMERLEC-30 comprises two Oerlikon 30-mm cannon with associated sights, below-decks ready-use magazine and an enclosed operator's cabin.





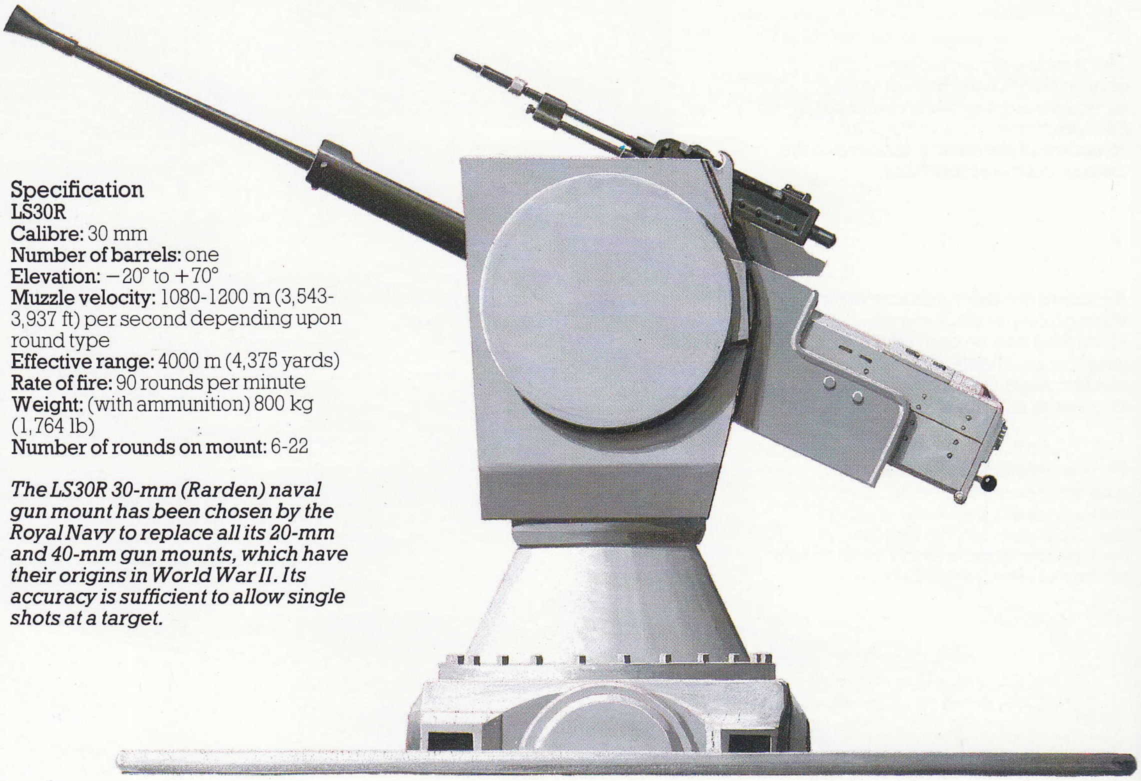
Originally developed for US Navy coastal patrol and interdiction craft under the designation EX-74 Mod O, the EMERLEC-30 mounting was taken up for export by the Emerson Electric Company and has been sold to a number of countries.

UK

30-mm LS30R (Rarden) Naval Gun Mounting

The British firm Laurence Scott (Defence Systems) has developed a lightweight naval mounting for the RARDE-designed 30-mm Rarden automatic cannon. The gun is both power-driven and line-of-sight stabilized for use on small naval vessels as well as on large frigate or destroyer designs. An extensive series of tests were carried out by the Royal Navy both at sea (aboard the converted trials frigate HMS *Londonderry*) and on land (at the Fraser Gunnery Range at Portsmouth) to confirm the high accuracy of the weapon, which hit a 2-m^2 (21.5-sq ft) target some 80 per cent of the firing time at ranges between 1000 and 1300 m (1,095 and 1,420 yards) in good to poor visibility. If required the mount can be fitted with a predictor, image intensifier, IR camera and/or low-light TV camera for remote firing. The ammunition types used include HE, APSE and APDS rounds. The **LS30R** has been adopted for use by the Royal Navy, and will be used to replace the older 20-mm Oerlikons and 40-mm Bofors from 1986 onwards. The first fit will be to the Offshore Patrol Vessels. The basic mounting can also be used with other types of 30-mm cannon such as the Oerlikon KCB and the Mauser Model F, in which case the designations become respectively **LS30B** and **LS30F**.

Specification
LS30R
Calibre: 30 mm
Number of barrels: one
Elevation: −20° to +70°
Muzzle velocity: 1080-1200 m (3,543-3,937 ft) per second depending upon round type
Effective range: 4000 m (4,375 yards)
Rate of fire: 90 rounds per minute
Weight: (with ammunition) 800 kg (1,764 lb)
Number of rounds on mount: 6-22



The LS30R 30-mm (Rarden) naval gun mount has been chosen by the Royal Navy to replace all its 20-mm and 40-mm gun mounts, which have their origins in World War II. Its accuracy is sufficient to allow single shots at a target.